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THE NATURE AND TREATMENT  
OF  
DIPHTHERIA.  
R. W. PARKER

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THE NATURE AND TREATMENT  
OF  
DIPHTHERIA.



# DIPHTHERIA:

ITS

## NATURE AND TREATMENT.

WITH SPECIAL REFERENCE TO THE OPERATION,  
AFTER-TREATMENT, AND COMPLICATIONS  
OF TRACHEOTOMY.

BY

ROBERT WILLIAM PARKER,

SENIOR SURGEON TO THE EAST LONDON HOSPITAL FOR CHILDREN;  
SURGEON TO THE GERMAN HOSPITAL.

THIRD EDITION, LARGELY RE-WRITTEN.

LONDON:

H. K. LEWIS, 136, GOWER STREET, W.C.

1891.





INSCRIBED

TO MY MEDICAL AND SURGICAL COLLEAGUES,

TO THE RESIDENT MEDICAL OFFICERS,


AND

TO THE NURSING STAFF,

(PAST AND PRESENT)

OF THE EAST LONDON HOSPITAL FOR CHILDREN,

AS AN EXPRESSION OF MY APPRECIATION OF THEIR UNFAILING  
KINDNESS; OF THE READY HELP AND ASSISTANCE THEY  
HAVE GIVEN ME IN MY HOSPITAL WORK,  
DURING MANY YEARS.



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## PREFACE TO THE THIRD EDITION.

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THE Author would again remind his readers that this monograph in no way pretends to deal exhaustively either with Diphtheria or with Tracheotomy. Its object is to record his own personal experience of Diphtheria as seen in London and its neighbourhood, as well as the treatment which in his hands has proved the most satisfactory.

The chapters on Diphtheria have been entirely recast, and the general subject more fully dealt with than in the two former editions. The main contentions are:—That Diphtheria is a purely local disease in its initial stage, very largely local in its subsequent stages, and that the constitutional symptoms are secondary to the local lesion.

The Treatment advocated is intended to control or alter the local lesion, and to remove or sterilise the morbid products of this lesion as rapidly and as efficiently as possible. The fact cannot be too strongly emphasised that the operation of Tracheotomy is not a therapeutic measure; that it is only a surgical expedient to ward off suffocation, and to gain time,

while treatment, more properly so-called, is being carried out.

The Author takes this opportunity of acknowledging his appreciation of the "*Mention Honorable*" which the Academy of Medicine of Paris did him the honour to accord to the previous edition of this monograph.

LONDON, 1891.

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# NATURE AND TREATMENT OF DIPHTHERIA.

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## CHAPTER I.

### ETIOLOGY OF DIPHTHERIA.

*Definition.—Etiology—A specific virus—Nature and Source—Klebs-Loeffler bacillus—Arguments for and against—Proximate and predisposing causes—Association with other zymoses—Usual carriers of the infection—Influence of aggregation—Season—Localities—Age and sex—Protective influence of previous attacks.*

#### DEFINITION.

FOR THE PURPOSES OF THIS ESSAY, diphtheria will be defined as the local and general manifestations of an infective virus, primarily attacking mucous membranes, the throat, the nose, and the air-passages being the “seats of election.”

The disease is characterised in the early stages by swelling and infiltration of the affected parts, subsequently by the deposit of a fibrinous exudation into and upon these parts, beneath which there is a variable amount of ulceration or of necrosis. Though a purely local disease in the first instance, it tends rapidly to generalise, is very apt to be accompanied by symptoms of severe blood-poisoning,

and to be followed by anæmia, great nervous depression, and localised paralyses.

Diphtheria has existed for centuries, apparently in all countries, and has received special attention from the best medical writers, not only on account of its very fatal nature, but also on account of the interest which attaches to such a mysterious and difficult subject. Under a variety of names:—the following among others, membranous, malignant, erysipelatous, and gangrenous angina, spotted throat, putrid sore-throat, diphtheritic sore-throat, croup, diphthérite—the disease has been described over and over again. In former times, as now, both during epidemics and in sporadic cases, the symptoms have greatly varied, this one or that being specially prominent, according to the country, the season, or other concomitant circumstances, as well as the part primarily affected.

The terms “diphtheria” and “diphtheritic” in this country are almost entirely applied to the disease as seen in the throat, the nose, or the air-passages; but diphtheria may occur on the vulva, on the cornea, on ulcerated surfaces on any part of the body. On the Continent and in America such occurrences seem to be quite common; in England they occur with great rarity, if at all. I do not remember to have seen a single instance of typical diphtheria of the vulva or of any part except the throat or nose at the East London Children’s Hospital among the many cases of diphtheria, which have been brought to the hospital during the past fifteen years, and I have not known a case occur in the hospital during the same period.

Professor OERTEL’s most recent researches tend to show that the so-called “false membrane” is not an essential feature in diphtheria, and that it is certainly not pathognomonic of the disease. According to this author, false membrane is but an accident of position; such formations



can only take place after antecedent—probably vascular—changes in the mucous membrane. He shows that in the early stages of the disease the epithelial and leucocytal elements disintegrate to form the substratum of the false membrane, just as cell disintegration produces the “necrobiotic foci,” which though more deeply placed in the tissues are equally characteristic.

### ETIOLOGY.

Under this heading I shall briefly discuss the essential cause of diphtheria, as well as the conditions which predispose to its incidence, or appear to favour its further spread.

*a. ESSENTIAL CAUSE.*—The disease is the direct result of the infective virus on the epithelium of the affected mucous membrane, and, at first, is a purely local lesion. “The virus precedes and underlies the anatomical change.” Once established it spreads locally by the contagion of its own morbid products, and it is in consequence of the absorption of these same morbid products through the lymph and blood that the system gradually becomes invaded. Occasionally, however, in some individual cases and in times of epidemics, the local manifestations appear simultaneously with symptoms of profound blood-poisoning, the latter even outweighing the former. It is not difficult to imagine, apart from other possible explanations, that when the poison is very abundant and very highly organised the resulting disease will present varying types of sthenicity. Authors are not agreed as to the exact source and nature of the contagium. Can it originate *de novo*? Is it merely some contagious product of inflammation? Is it a living organism? If an organism, is the disease produced by

its mere presence or by some chemical poison which the organisms generate in the body? Lastly, can this organism give rise to the disease at all periods of its life, or only on attaining a certain maturity? Or is diphtheria a disease due to an organism capable of producing its special effects only when working in concert with certain other organisms, as OERTEL has it, is diphtheria a "Mischinfection von specifischen Bacillen und septischen Kokken?"

I do not propose to discuss these points at any great length in this monograph. Suffice it to say here that I, personally, repudiate the *de novo* origin of the virus on general grounds. It would indeed be strange that a disease so largely diffused over the world, and subject to such varying conditions of climate and soil as is diphtheria, should bring about the characteristic symptoms and pathological changes, which are universally recognised in typical diphtheria, if it depended on some indifferent infective virus constantly originating *de novo*. Furthermore, the large amount of existing virus, the facilities for its transference from existing sources to others, and the absolute impossibility of excluding such a mode of infection in given cases deprive the *de novo* arguments of all point.

Besides human beings, it must be remembered that the lower animals, as well as birds, domestic fowls, &c., are all liable to suffer from a disease, which, if not actually identical in its manifestations with human diphtheria, so closely resembles it, that little doubt can exist as to the essential and practical identity of the two forms. In tracing epidemics, and in seeking for centres of infection, a knowledge of these facts is highly important. Dr. GEORGE TURNER has presented a most interesting report on this subject to the Local Government Board, to which the reader is referred.

As to the intimate nature of the contagium, the majority of, as well as the most esteemed, authorities of to-day regard the disease as due to the action of a specific vegetable organism (fungus). It is largely to the work and teaching of Professor OERTEL of Munich, that this important fact in the etiology of diphtheria has come to be so generally accepted. More than twenty years ago, he put forward this view, which subsequent investigations have only tended to confirm and extend. But authors are not yet quite agreed as to exact nature and life history of this organism. Professor OERTEL, himself, in a recent work on the 'Histological Anatomy of Diphtheria,' admits that the causal connection between diphtheria and organisms is not yet clearly made out, and thinks that more light may probably be got from a careful study of the histological characters of the diseased structures.

Among the most important and most recent researches on the bacteriological aspect of diphtheria must be mentioned those by Professor LOEFFLER, carried out in the "Gesundheitsamt" of Berlin, over which Professor KOCH now presides, and thanks to whose more elaborated methods of study such important advances have been made. For the following account, I have made free use of Dr. HIME's abstract of LOEFFLER's paper, contained in the New Sydenham Society's 'Microparasites,' edited by Mr. WATSON CHEYNE, to both of whom I now express my obligations.

Professor LOEFFLER examined twenty-seven cases, which being rather different among themselves, he divided into two classes, according to the organism present in largest numbers:—

CLASS I.—The clinical characteristics of the first class were, loss of epithelium on the surface of the affected mucous membrane, and loss of tissue substance; no false

membrane. On the denuded surface of the mucous membrane and also through its substance, were long chains of rather large micrococci. These organisms were also found in the lymphatics, through which they passed into every part of the body; it must, however, be stated that chain-forming micrococci, morphologically identical with those found in diphtheria, are present in various other diseases.

CLASS II.—The cases in this class were characterised by a thick false membrane extending over the mucous membrane of the fauces, larynx, and trachea, the mucous membrane being traversed by enormously dilated and overfilled vessels. Below the masses of bacteria of different kinds which covered the surface (and among which the chain-forming micrococcus just referred to was also found) KLEBS' bacilli were found arranged in small groups. In one case almost the whole false membrane consisted of colonies of this peculiar bacterium.

Pathological anatomy thus failing to explain the etiological significance of these organisms, LOEFFLER made some pure cultivations of them, and after experimenting with them on various animals, he arrived at the following conclusions.

As to the streptococci:—they cannot be regarded as the specific cause of diphtheria, because—

(1) When inoculated on the other animals they never produced a disease even resembling diphtheria.

(2) They are only found in a limited number of cases of human diphtheria.

(3) They are found on and in affected parts along with the bacillus which is described below.

(4) They are found in internal organs in other diseases.

As to the bacilli:—the following facts are evidence in favour of their specific character:—



(1) They have been found in large numbers in many typical cases.

(2) They lie in the oldest part of the false membrane and penetrate deeper than any other bacteria.

(3) They produce remote effects similar to those found in true diphtheria.

(4) They affect young animals more easily and more quickly than old ones.

On the other hand, the following arguments may be urged against their specific character :

(1) They are not always present in typical cases.

(2) They are less typical in their arrangement in some animals.

(3) Animals, which survived inoculations, never presented paralytic symptoms.

∴ Eleven per cent. is the highest percentage in man in which paralytic symptoms have appeared.

(4) A bacterium is sometimes found in the saliva of the healthy child; which morphologically is indistinguishable from the bacillus of diphtheria.

∴ It is conceivable that, when diphtheria is prevalent, the virus may be present in the throat of a child without producing any morbid effect.

LOEFFLER's diphtheria bacilli (which appear to be morphologically identical with those previously described by KLEBS) are non-motile, and are quickly and deeply stained with methylene blue ; some are straight and some slightly curved. They vary considerably in length, being on an average about the length of the tubercle bacillus but twice as thick. The long ones are composed of several members, and where these are connected there is frequently a slight knotty enlargement. In not a few individuals one terminal member, or both, may appear

slightly thickened. Frequently the pole of the bacillus is more deeply stained than its substance. This is distinctly shown when blue preparations are treated with iodine solution, as the body of the bacillus is easily decolourised, while the poles remain deep blue ; this gives some of them the appearance of a dumb-bell.

Even after the cultivations were kept for a week in the incubator spores were never seen by LOEFFLER, such as are obtained in other bacteria by the impossibility of staining them, and by their brighter appearance on central illumination. Exposure to a temperature of 140° F. for half an hour destroys the bacilli without exception. The length of life of these bacilli appears to be about three months. They require for their development a temperature above 68° F.

Within the last twelve months, however, the belief has fast been gaining ground that disease is not produced by the mere mechanical presence of the microbe, but rather that the microbes give rise to certain chemical products, which act as poisons, and that these latter are the real cause of disease. These toxic products are of the nature of albumoses : in some cases the albumoses may be further elaborated and an alkaloidal poison produced, which is rapidly fatal in certain doses whether produced in the body itself, or, after separation, injected hypodermically.

If a chemical cause of diphtheria be the correct one, it will well explain some of the differences in the symptomatology which occur among the cases. For if a material chemical product be elaborated, it is quite easy to understand that it may be conveyed as such from one person to another, and that its action will be more imme-



diate, than when merely the microbes are transferred from one source to another ; in the first case, the toxic chemical product is ready to hand, while in the other case the microbes require time to multiply and to produce this toxic product.

Against these views, it is sometimes urged that the disease, as seen in man, has not been at all accurately reproduced in animals by experimental inoculations.

That diphtheria clinically presents great differences in its intensity, and in its infectiveness must be conceded, but these circumstances are not, it seems to me, adequate arguments against the view that the virus, which causes it, is specific. If we think how minute such organisms are, how difficult it is to study their life history, how apt they are to be influenced by their environment, how their products will come to be modified both in quantity and in quality, and how largely all disease is controlled and modified by the constitutional power of the person affected we need be no longer surprised at the varying phases which we meet with in diphtheria nor seek further for explanation of them.

Experimental research has conclusively demonstrated that the media, in which such organisms are grown, greatly modify their vital and pathogenic powers. Thus PASTEUR has shown that the fission-fungi (*Schizomices*) found in the so-called "chicken cholera" flourish most abundantly and retain their virulence best in neutralised chicken broth ; that the same germ grows very sparingly in neutralised urine, while in a decoction of beer-yeast, in which the anthrax bacillus grows very abundantly, this cholera germ not only does not grow, but cannot live.

And finally in carrying out experimental investigations and pure cultivations, it must be remembered that it is

quite impossible to reproduce conditions exactly identical with those, which obtain in the human body. Even the multiplicity of organisms found in any given case during life may modify the influence and products, which any one of the organisms so found would produce, if alone.

(b) PROXIMATE AND PREDISPOSING CAUSES.—Undoubtedly an infectious as well as a contagious disease, diphtheria, in this country at least, is sporadic more frequently than epidemic in the strict sense of the term. Over and over again I have met with well-marked, even malignant diphtheria coming from poor over-crowded homes in East London, in which there has been but one case in the family, notwithstanding that no special care or precaution had been exercised to prevent spread of the contagion in the home. It is true that in recent years extensive local outbreaks of diphtheria have occurred in many places; but as they have nearly always been traced to some common and imported source, a milk or a water supply, the term “outbreak” seems better justified than would be the term “epidemic.”

I am beginning to attach less value to the generally accepted view that families enjoy some special proclivity to diphtheria and that when one member gets the disease the remaining members must be regarded as being specially vulnerable in this direction. The essentially sporadic nature of diphtheria in and about London—a fact for which I can vouch from personal observation—speaks strongly against the acceptance of any such view.

In this connection some observations, by Mr. POWER in his Reports to the Local Government Board are much to the point and moreover authoritative “not infrequently” he says, “severe and fatal diphtheria appeared destitute or well-nigh destitute of power to infect other children

living along with it. On the other hand, cases of very trivial sore-throat or 'colds' that were not perhaps heard of (except by close questioning) often preceded and were seemingly responsible for after-occurrences of true and fatal diphtheria in the family."

My interpretation of such cases, and I have seen many, is that any unhealthy, inflammatory or otherwise, conditions of the nasal, pharyngeal, or laryngeal mucous membranes—such as, chronic nasal, or pharyngeal catarrh, post-nasal adenoid growths, large tonsils, "relaxed" throats—provide a specially suitable soil for the development of the diphtheritic virus; if such conditions do not happen to prevail in a home, when the case of diphtheria occurs, spread of the disease does not take place; the virus remains clinging to the furniture or clothes, and when the favourable conditions present themselves, then it again takes root and gives rise to the characteristic symptoms. This relative non-infectiousness is a very fortunate circumstance, for disinfection is, at the best, but very poorly carried out by the sanitary authorities in the squalid homes of East London and elsewhere.

Diphtheria is frequently associated in the same individual with scarlet fever or measles, and by choice occurs at seasons when these zymotic diseases are prevalent. In some instances the diphtheria is much modified by this association, but in other cases the two diseases run side by side—and often a typical course. Whether such modifications, when they occur, are purely personal or whether they are due to the concurrence of two distinct zymoses must for the present remain a matter of conjecture. I regard this concurrence of diphtheria, however, with other exanthems as something more than mere co-incidences, and as due to the specific effect which scarlet fever and measles *per se* exercise on the mucous mem-

branes of the patients attacked. In the same way, too, scalds, the action of corrosive fluids, of heated air, and common catarrh of the pharynx and larynx are important etiological factors in determining or predisposing to an attack of diphtheria, when infection is about.

CARRIERS OF THE VIRUS.—What are the most usual carriers of the virus in the cases which are not directly infected from some known and obvious source?—The air, water, milk, and articles of clothing are certainly amongst the most common.

AIR.—In the many cases for which no clear explanation is forthcoming, we are thrown back upon the air as the means by which the virus is carried to and from. The interesting Reports on Diphtheria made to the Local Government Board by their medical inspectors (chief among whom may be mentioned Drs. AIREY and BALLARD, and Mr. POWER), show that in many cases, the source of infection cannot be definitely associated with insanitary conditions, even when insanitary conditions largely prevail in the affected neighbourhood. Cases occur in good homes among children quite removed from insanitary conditions. For such cases there appears no other feasible explanation than that the virus has been conveyed in the air.

We are all familiar with cases which seem directly traceable to effluvia from drains; it can hardly be doubted that these effluvia—which are currents of sewer-gas—are then loaded with the specific morbid germs and produce typhoid fever, erysipelas, or diphtheria according to the nature of the germs which happen to be present; these effluvia are not necessarily offensive to the nose, an unfortunate circumstance perhaps, for were they always offensive, they would sooner attract attention and the dangers arising from their presence would be thus greatly lessened.



The frequency with which diphtheria—as well as other diseases—are attributed by the lay public to “draughts” has, I think, a solid foundation of truth. A “draught” may be defined as air in motion. We constantly get into draughts without getting disease therefrom, for the simple reason it may be presumed, that draughts do not always contain pathogenic micro-organisms. But if such currents of air do happen to be charged with them, and if the individual so exposed present suitable constitutional conditions the germs take root, and the disease manifests itself.

At the International Congress in London (1881) in the Section for Diseases of Children, Dr. AIREY read a most suggestive paper on the spread of diphtheria. In this paper he endeavours to show—and as I think very successfully—that the contagium is carried about by the wind. He founded his arguments on a careful study of the topographical characters of places, in which diphtheria is most frequent, utilising for the purpose the official reports made to the Local Government Board at different periods, as well as an extensive personal experience in tracing out the origin and cause of such outbreaks. In this paper he shows that the districts, in which rural diphtheria commonly occurs, are “in bleak and exposed situations”—“all the villages invaded by diphtheria, with scarcely an exception, are in elevated situations, many of them are on the ridge or slopes of the hill.”

Furthermore, as I have already said, the part primarily affected by diphtheria, in the great majority of cases, is the pharynx or nose, a circumstance which aërial infection explains better than any other; and by far the most common cause of death, even in cases in which the larynx and trachea never become seriously involved, is pneumonia,

a circumstance which aërial infection will explain as well as or better than any other.

**WATER.**—Water is also a very admirable contagium carrier. Considering its universality, the large amount of which is used for every conceivable purpose, it is remarkable how any person escapes when the water chances to be infected. In the rural districts (where diphtheria is most prevalent) the drinking-water is often taken from open springs, or from open brooks, or from wells, when such exist, which are often dangerously near cess-pools, privies, stables, or cowhouses, the surrounding soil being impregnated with the accumulated soakings of years. That such conditions continue year after year, and that families escape the disease, are facts which, to my thinking, speak with great force in favour of the specificity of the virus which produces diphtheria when it does occur. When diphtheria appears in connection with water, it has generally been found to be associated with surface contamination.

**MILK.**—Several extensive outbreaks of diphtheria have been traced to the milk supply. Mr. POWER has investigated such outbreaks, and has demonstrated, beyond all doubt, that milk is the medium by means of which diphtheria is most frequently carried from place to place. In one such outbreak it was shown that the cases all occurred within a period of seven days. In connection with another outbreak, Mr. POWER demonstrated that “though uniformly infective on leaving the farm, the milk had a very different effect in causing diphtheria, according as it was distributed to one or another class of consumers. This difference of effect had to do with difference in amount (and related difference of use and difference of conservation) of milk distributed in the two classes. The difference among better class consumers was, as regards amount



and fatality, so conspicuous that its relation to the milk-service was readily seen ; but among poor class consumers it was inconspicuous, and might easily have been overlooked . . . .” Thus it would seem, as is the case with other poisons, that the dose in which the poison of diphtheria is administered largely determines the issue in any given case.

INFLUENCE OF SCHOOLS IN DISSEMINATING DIPHTHERIA.—An etiological factor of great importance, but very obscure in its *modus operandi*, is the aggregation of children, as in schools. Mr. POWER has reported on this subject. In places where diphtheria prevails, the schools are closed, and are thoroughly disinfected. After some weeks, and when the diphtheria is believed to have died out, or to have been exterminated, the schools are reopened. Needless to say that no children are sent or allowed to attend in whom any visible or appreciable signs of the disease remain. Yet, notwithstanding, and within a very short time, and without being exposed to any new source of infection, fresh cases of diphtheria begin to appear among them. In other words, the children, while living separately, appear to be and to remain exempt from the disease. But with the same climatic conditions prevailing, as soon as they are massed together, typical disease quickly breaks out among them.

Such circumstances are in accordance with experimental observations, which go to show that some micro-organisms are capable of producing a minor and incommunicable disease at some stages of their development, but at later stages a more serious form of disease, both infectious and contagious. It seems to me that this fact helps to explain how a severe case of diphtheria sometimes gives rise to a mild one. We need only imagine that the germs

which have been transferred had not arrived at their full maturity.

It has been authoritatively shown also that genuine diphtheria and the progressive development of simple sore-throat into an infective sore-throat occur together, and that both coincide with damp weather, and with an abundant growth of various forms of mould.

SEASON.—The influence of season on the occurrence of diphtheria, as based on a study of 147 outbreaks, is thus stated by Dr. AIREY. The number of outbreaks occurring in—

January	is	4	}	=16	July	is	16	}	=38
February	„	6			August	„	11		
March	„	6			September	„	11		
April	„	8	}	=25	October	„	40	}	=68
May	„	6			November	„	16		
June	„	11			December	„	12		
Total in first 6 months=41					Total in second 6 months=106				

LOCALITY.—The localities affected, Dr. AIREY says, “are for the most part described as cold wet clay lands; but there is evidently great variety in the soils in which diphtheria can prevail, for it is found in full force on the chalk downs of Kent, on the loamy sands and clays of the Sussex Weald, on the alluvium and boulder clay of Essex, on the marls of the new red sandstone, and on the slopes of the slate rocks of Wales.”

AGE AND SEX.—The following facts are taken from the Registrar-General’s most recent report (1888); they are interesting, and suggestive in connection with the factors which predispose to diphtheria. It is shown that the mortality rises to its maximum during the fourth year of life, and then falls in each successive age period with the exception of an insignificant rise in old age. Further,

*Average Annual Death-rate from Diphtheria per Million living at Successive Age Periods, and per Standard Million at all Ages.*

Period taken for calculation.	Total deaths in period.	All ages per Standard Million.	Annual mortality per million living.										
			Under 5 yrs.	5—	10—	15—	20—	25—	35—	45—	55—	65—	75 and upwards.
1859 to 1887	M. 53,086	157	655	337	100	46	27	19	18	19	24	25	23
	F. 59,988	176	664	434	147	53	30	24	21	16	19	19	20

*Annual Death-rate (Diphtheria) per Million at each of the first five years of Age.*

Period taken for calculation.	Total deaths (Diphtheria) under 5 years of age.	Annual mortality per million living.				
		Under 5 years.	Under 1 year.	1—	2—	3—
1859 to 1887	M. 30,358	655	464	720	675	757
	F. 30,756	664	356	665	731	835
						690
						782

that the mortality after the first two years of infancy is much higher in the female than in the male sex. Diphtheria is the only zymotic disease, with the exception of whooping-cough, to which females furnish, out of equal numbers living, more victims than do males.

The chief lesson to be learnt from these facts and figures is that the incidence of the disease is also greatest at the ages when the mortality is highest. In doubtful cases, therefore, the probabilities both as to diagnosis and prognosis must be constantly kept in mind.

DOES ONE ATTACK OF DIPHTHERIA PROTECT THE SYSTEM FROM FUTURE ATTACKS?—I was formerly inclined to believe that one attack of diphtheria in no way protected the system from a second. But I now think that this view is incorrect. More or less protection or immunity is certainly gained by passing through an attack of diphtheria, just as is the case in scarlet fever, measles, or smallpox. This immunity, however, is not by any means absolute in any of these diseases. I am acquainted with many more instances of second and even of third attacks of measles than of second attacks of diphtheria. That second attacks of diphtheria occur, I must needs allow, for I have it on the authority of those whose opinion I am bound to accept. But I happen never to have met with a second attack of undoubted diphtheria in my own practice.

If the principle on which vaccinations are carried out be correct, and I do not in anyway doubt it—one attack of diphtheria must secure immunity for a certain period. The “hospital throat” which so many house surgeons, dressers, and nurses get when they first assume office, and the subsequent immunity which the majority enjoy, are most logically explained on such a hypothesis.

I know an instance of a lady nurse, who suffered rather

more than usual from hospital sore-throat. She contracted diphtheria, which was followed by some anæmia and pharyngeal paralysis lasting for many months. This lady has never since suffered from hospital sore-throat and is now in excellent health, and head of the nursing department of her hospital.

Dr. JACOBI on the contrary says: "diphtheria once ended creates a predisposition. It may be that the mucous membrane undergoes, in the first attack, such changes of a catarrhal or merely anatomical (epithelial) character as to fix that predisposition. It may be that in the enlarged glands diphtheria poison is stored away for occasional resuscitation, as we know it to be, for instance, in syphilis."



## CHAPTER II.

### CLINICAL CHARACTERS OF DIPHTHERIA.

*Incubation period—Mode of onset :—of pharyngeal diphtheria—of nasal diphtheria—Lymphatic glands. Laryngeal diphtheria :—primary—secondary. Short illustrative histories. Differential diagnosis. Features of the diphtheritic inflammation—complications and sequelæ—Prognosis.*

INCUBATION.—The period of incubation varies very considerably. TROUSSEAU gives from two to seven days. OERTEL two to five days. HENOCH seven days as an average. JACOBI gives two days or more. GOODHART says “the incubation period ranges from two to eight days, three days being a usual time to elapse between the reception of the germ and the first symptoms.” MONEY says the incubation of diphtheria is effected in four to six days. These figures give an average of from 2·4 to 5·6 days.

I have myself known a case to occur within a few hours of exposure to a known infection, and other cases in which an interval of three weeks has passed over. From my own experience, I should say that between four and five days would be a safe average to be guided by.

In any given case the exact incubation period will probably depend upon (1) Whether epidemic or special influences are at work. (2) Whether the individ-



ual, when exposed to the contagion, is in good health or the reverse. (3) Whether any local conditions exist favourable to the development of the virus. A catarrhal condition of the mucous membranes, especially of the pharynx, undoubtedly renders individuals more receptive to the influence of the poison than they are when in health. It is, I think, probably on this account that diphtheria is so frequently engrafted on measles and on scarlet fever, in both of which diseases the mucous membranes also suffer. Open wounds, especially recent ones, appear to favour the ingress of the virus. It would seem also very probable that the amount of poison absorbed, and possibly its degree of maturity at the time, will influence the duration of the incubation-period, and the onset and character of the resultant disease.

Not a few cases of diphtheria run their entire course without being recognised: other cases are not recognised until all local signs have completely passed away, and are surmised to have occurred, only when the appearance of certain sequelæ—a peculiar form of temporary paralysis—draws special attention to the cases. It will always remain doubtful whether in such cases the characteristic symptoms have been absent or overlooked.

It has already been stated that diphtheria is, at the onset, a purely local disease: it naturally follows that the early symptoms will present diversity according to the function of the organ or part first affected. Nor can it be doubted that the age of the patients attacked will materially modify the symptoms as well as the course of the disease.

The parts most commonly affected, arranged in their

order of relative frequency, are the pharynx ; the nose ; the larynx and trachea.

PHARYNGEAL DIPHTHERIA.—This form of diphtheria commences not infrequently with symptoms of simple coryza, that is to say, there will be nothing to distinguish the the coryza from that accompanying an ordinary “cold.” Should possible sources of infection be inquired for, nothing definite may be forthcoming. After two or three days, or even a week, the appearances will gradually assume a characteristic aspect. Whether the diphtheritic poison in such cases has been absorbed before the coryza first manifests itself and is its original cause, or whether the catarrhal condition simply favours the development of the virus, which was in the neighbourhood of the patient and ready to take root when suitable soil and conditions presented themselves, are questions which it is difficult to answer. Personally I incline to the latter hypothesis.

Or a child may be noticed to be less active and playful than usual ; wants to be nursed or put to bed : declines its food : feels hot and feverish. Being taken to a doctor, the temperature is found to be raised ; the skin is dry, the absence of rash is noted : an examination of the throat shows a little congestion, but nothing at all characteristic. The symptoms, however, do not yield to treatment, and are somewhat more marked after twenty-four hours. On examining the throat again, the fauces will be found redder and more inflamed, and the tonsils more prominent. A day or two later, the tonsils may be spotted over with opaque yellowish-white spots, corresponding to the orifices of the mucus crypts, and some stiffness about the angles of the jaw will be complained of. There will usually be some enlargement of the submaxillary lymphatic glands. All the general symptoms will become intensified : there will be

greater lassitude, more fever, probably a hoarse, husky or "croupy" cough, coated tongue, and foetid breath. The symptoms now rapidly acquire a characteristic aspect—the spots on the tonsils enlarge, develop into patches of "false membrane," and spread on to the soft palate, uvula and posterior pharyngeal wall.

In other cases, especially in older children, attention will be drawn to the throat by the complaint of pain, difficulty in swallowing, and by an alteration in the quality of the voice. An acute or a subacute tonsillitis may appear threatening, and after a day or two, develop into typical and even severe diphtheria.

NASAL DIPHTHERIA.—When the disease attacks the nose, there will first be noticed some slight obstruction to the breathing, then a little redness within the nostrils; soon there will be a muco-purulent, offensive discharge by the anterior nares, with or without excoriation of the skin and upper lip. In many of these cases there may have been an antecedent discharge, suggesting chronic inflammation, so that little or no attention is paid by the parents to the newer discharge, nor to the nasal voice, and the partial nasal obstruction which accompany such conditions. It is obvious how they will favour as well as conceal the development of such a disease as diphtheria. When nasal discharges are found together with pharyngeal diphtheria, it is almost certain that the nares are likewise affected, and they demand most careful attention and treatment.

Diphtheria of the nose is nearly always severe in type, which may be explained perhaps by the fact that it is especially liable to attack children with unhealthy nasal cavities. The intensity of the disease can be fairly gauged by the amount and character of the discharge, by its odour, and

by the amount of excoriation to which it gives rise ; this discharge is thin, sanious in character ; the more diphtheria predominates over catarrh, the less mucoid in quality will this discharge be found ; not infrequently shreds of characteristic membrane will be discharged, with traces of blood in some instances.

Lymphatic glands.—As regards the lymphatic glands, there is nothing very characteristic. They are usually involved in faucial and in nasal diphtheria ; but the extent of this involvement is not always proportionate to the apparent intensity of the diphtheria, and especially in the early stages. The amount and character of the swelling depend on the personal idiosyncracies of the patient in diphtheria as in other conditions leading to affection of the glands. Dr. GOODHART, in his excellent handbook on the ‘Diseases of Children,’ insists particularly on their hardness, and regards this as often a most characteristic feature. I confess this point has escaped my observation.

The disease sometimes comes on with startling rapidity and intensity, the local conditions being widely spread, and the constitutional symptoms severe, sometimes overshadowing the others. In such cases as these, there is no difficulty about the diagnosis. Nervous depression, high temperature, vomiting, diarrhœa, general malaise, fœtor of the breath, sordes or even ulceration about the lips, enlarged glands beneath the lower jaw, nasal discharge will at once be apparent and the meaning pretty obvious. On examining the pharynx, the tonsils, uvula, and soft palate, the whole pharynx in fact will be œdematous and patched over, or completely covered, with “false membrane ;” at the margins of the membrane, the ulcerative process, so characteristic of diphtheria, will be



seen, there being no clear line of demarcation between the ulcerating and the adjoining parts. Some patches of membrane may be loose, hanging on by shreds, and leaving visible the ulcerated and sloughy surface, from which they have become detached. The amount of congestion and redness will vary both in tint and intensity. If there be any implication of the inspiratory tract, especially if there be any marked dyspnœa, the colour will be livid or bluish, and the amount of swelling greater.

But the mode of onset varies greatly in different individuals, even in those who have been infected from the same source, not only in the duration of the incubation period, but also in the severity of the symptoms, thus showing what a large 'personal element' there is in each case.

LARYNGEAL DIPHTHERIA.—It is not my intention to enter at any length on the still open question—the identity or non-identity of "membranous croup" and "laryngeal diphtheria." The question has been fully discussed during recent years, and nothing new remains to be said.

Suffice it here to state that I agree with those who consider that these diseases are etiologically identical; thus, the terms "membranous croup," "membranous laryngitis," "laryngeal diphtheria" used in this monograph are to be regarded as synonymous. They are, as BRETONNEAU puts it, "one and the same species of disease, the phenomena of which present a great diversity of symptoms, according to the function of the organ affected."

MODE OF ONSET.—Briefly it may be said that laryngeal diphtheria is essentially a disease of childhood, and that it begins in one of two ways:—the disease may attack the larynx primarily, or beginning elsewhere,

may spread to the larynx secondarily. In the former case, the chief symptom is dyspnœa, or even suffocation in acute cases; in the latter, the laryngeal are preceded by general symptoms, the laryngeal onset being generally much more insidious—less acute. In both varieties of the disease, the symptoms, and the general as well as local intensity, vary within considerable limits, being modified by season and by surrounding, as well as by the age and size of the child attacked.

1. DISEASE PRIMARILY AFFECTING THE LARYNX.—To judge from my own experience, I should think this is a very rare form of disease. It has, however, been described by many authors since Dr. FRANCIS HOME (1765) first drew attention to it and called it “croup.” Though a very fatal disease by common consent, I have made only two *post-mortem* examinations of cases, which could be truthfully described as purely laryngeal diphtheria.

I have seen quite a number of cases of so-called “croup,” the purely laryngeal symptoms coming on very rapidly, in which nothing characteristic of diphtheria could be seen in the pharynx, and have operated on such cases, sometimes successfully sometimes unsuccessfully. But when I have subsequently examined the bodies after death, I have almost invariably found that the disease was not confined to the larynx. This is one of my strongest reasons for regarding the onset in the larynx as an accident, and in no sense characteristic of a disease peculiar to the larynx or distinct from diphtheria as commonly understood. Any differences which may exist in the two forms of disease are more than explained by the fact that laryngeal diphtheria, unless relieved by operation, is usually fatal before other pathological phenomena have had time to characteristically develop themselves.

As in diphtheria of other parts there is always a



prodromal stage; the symptoms during this stage may be more or less obvious, and are often very insignificant and neutral in their features. But I believe that true membranous croup rarely, if ever, comes on, as is sometimes taught, without antecedent malaise and feverishness for two or three days. The child is said to have caught cold, and there is generally some cough. This cough gradually assumes a peculiar ringing clang—described as “croupy,” and the voice becomes a little husky. Writing on this subject, Dr. WEST, in his classical work on the ‘Diseases of Children,’ says, “. . . Soon after this modification of the cough has become perceptible, or even simultaneously with it, the respiration undergoes a change no less remarkable. The act of inspiration becomes prolonged, and attended with a stridor, as difficult to describe but as characteristic of the disease as the tone of the cough. It often happens that these two pathognomonic symptoms first come on, or at least first excite attention, in the night, and that a child who at bedtime was supposed to ail nothing, or at most to have a slight cold, awakes suddenly with ringing cough, and stridulous breathing, frequently in a state of alarm with marked dyspnoea. Through the whole course of the disease, indeed, an obvious tendency exists to nocturnal exacerbations, and to remissions as the morning approaches.

“Soon, however, the dyspnoea returns with increased intensity; the whole chest heaves with the inspiratory effort, which is more prolonged and attended with greater stridor. The cough does not increase in severity in proportion as the disease advances . . . From the first appearance of the more marked symptoms the voice is hoarse, cracked, and whispering, or, in young children, is totally suppressed. . . . As the disease advances

the intermissions grow less distinct, and the child is constantly engaged with the effort to respire. . . .”

In other cases the essential laryngeal symptom—dyspnœa—on account of its vital significance may be, and indeed often is, the first symptom to attract attention. Associated with this dyspnœa there will be restlessness; for a child whose larynx is nearly closed up with false membrane cannot lay still or sleep. The absence of cough and of power to cry just alluded to, though a symptom of grave importance, conveys more meaning to a doctor than to the child’s friends.

Should laboured breathing, coming on almost suddenly and without any very obvious cause, suppression of voice and cry, and great restlessness be found co-existing in any child, its condition is grave indeed.

I will not attempt to describe the symptoms of the last stage of this form of the disease, for one object of my book is to advocate that surgical help be afforded before matters are allowed to come to this pass.

2. DISEASE AFFECTING THE LARYNX SECONDARILY.—This form of the disease is preceded and accompanied by diphtheria of neighbouring parts, as already described. To recapitulate, however, “sore throat,” as it is popularly expressed, some difficulty in swallowing and some little stiffness of the jaw will probably be among the earliest signs. On examining the pharynx, its mucous membrane will be found swollen, œdematous and *glacé*, and its surface patched over with membrane. The tonsils are usually enlarged and dotted over or covered with membrane; the uvula is very generally involved. The glands at the angles of the lower jaw are usually swollen, tender and hard (GOODHART). The breath is foetid. There is generally great constitutional disturbance; fever, a hot and dry skin, restlessness and prostration. The voice at this

stage will be pharyngeal in quality. Attempts to swallow cause pain and uneasiness.

As a rule, extension to the larynx is very gradual and very insidious; and herein, it seems to me, is an explanation of one of the most palpable clinical differences between this variety and primary laryngeal disease, described in the last section. In consequence, partly of the antecedent blood poisoning, but chiefly of the very gradual onset of the disease, the body becomes reconciled to its deprivation of oxygen; hence the suffocative symptoms, so prominent and so distressing in the other variety, are less marked, indeed often absent, in this. I have seen the disease far advanced before any surgical aid has been sought, the parents having been misled by the absence of any "croupy" cough or struggling for breath, which are so often looked upon by them as the essential indications of "croup." Sometimes medical men have themselves under-estimated the gravity of the disease on account of this apparent absence of discomfort in their patients.

This gradual spread of pharyngeal diphtheria to the larynx is a dangerous mode of onset. For a child accommodates itself to an amount of disease when it comes on gradually, which could not be tolerated were it sudden in its onset. Thus there is danger of under-estimating the extent to which the air-passages are involved in many of these secondary cases. All this time, too, the absorption of morbid products from the pharynx into the system at large and their further multiplication in the body are going on, and adding largely to the dangers, which necessarily attend the presence of membrane in the diminutive larynx or trachea of a young child. FAGGE states that when extension to the larynx occurs, it is within three to six days after the com-

mencement of the original disease. Sir WILLIAM JENNER, in 1861, had never known it delayed beyond the end of the first week, but OERTEL says it may be as late as the thirteenth day.

Both in primary and in secondary diphtheria of the larynx the amount of mechanical obstruction present in any given case may very well be estimated by an inspection of the chest: with each inspiratory effort there will be retraction of the soft parts of the chest-wall; the spaces above the clavicles and the suprasternal notch, as well as the intercostal spaces, will all sink in, instead of filling out. The soft parts around the xiphoid cartilage also will be drawn in, and quite a large depression may be formed.

Moreover, expiration will be laboured as well as inspiration; and this is a very pregnant sign, for nothing short of mechanical obstruction can account for it.

As illustrating the diversity in the mode of onset in cases which the sequel has proved to be typical diphtheria, I propose to extract from my note-books a few histories, such as I received them when seeing the cases for the first time. These histories were mostly given me by the doctor in attendance, and were not in any way obtained for the purpose for which I am now using them. They serve to show how obscure and how diverse the early manifestations of the disease may be in different children and in different circumstances.

HISTORY 1.—Boy, aged 4 years, had been “ailing” for more than a week, but the parents had not considered it necessary to call in medical aid. He had run about and taken his food much as usual. His nights had been a little restless, and sometimes he had complained of pain in the throat.

When seen by the doctor, there was well-developed membrane covering the back of the pharynx; some pieces were depending from the soft palate, and the remains of former membrane on the tonsils were also visible. There was no difficulty in



breathing, nor any indication that the larynx had been attacked. The temperature was  $101.5^{\circ}$ ; the pulse 110 per minute. There was no prostration, no outward evidence of serious illness. The parents were under the impression that the boy had merely an unusually persistent sore-throat.

HISTORY 2.—Boy, aged  $5\frac{1}{2}$ . Returned home from school one day, complaining of headache and stomach-ache. His mother found him very hot and feverish, and thirsty. He was put to bed; this condition lasted with little change and no improvement for about one week. Then he got up and went about again. Nine days from the commencement, towards evening “he began to be choky, and to cough—his cough was very bad, it seemed as if it would choke him.” He was up and dressed. On the eleventh day “he could sit up no longer. On the thirteenth day I made the following note: “He is on his mother’s knee; is exceedingly restless; voice is nearly suppressed; there is no urgent dyspnœa, but inspiration and expiration are both somewhat laboured; he can walk about, and did so without any increased difficulty in breathing. The countenance is livid, lips slate coloured; eyes wide awake and staring. The fauces are livid; tonsils not markedly altered; tongue white, coated and dry. Nares normal; no appearance of membrane anywhere.”

No history of “croup” or throat affection to be obtained.

HISTORY 3.—Boy, aged  $2\frac{1}{4}$  years. Was cross and fretful one afternoon eight days ago. He seemed very hot; there was no cough; no difficulty in swallowing. He slept well during the next night; next day was less feverish. On the two following days total remission of all symptoms. Four days ago, in the morning on being dressed his cry was observed to be hoarse and “croupy.” He remained restless, and had some cough for another three days.

When seen on the eighth day, I noted an entire absence of lividity, and that the boy, as far as outward appearances went, seemed fairly healthy, except that he was drowsy; but on examining the throat, the whole of the pharyngeal mucous membrane was inflamed; the tonsils, so enlarged as almost to meet in the middle line, spotted over with islands of white membrane—the uvula was also affected. The urine contained a little albumen.

HISTORY 4.—Boy, aged  $2\frac{1}{4}$  years; was under careful medical observation the whole time; for three weeks he had complained of sore-throat, and said it hurt him to drink, but could take

solid food without pain. An examination of the throat, undertaken repeatedly during these three weeks, revealed nothing beyond congestion. One day, after three weeks as above described, there was a cough of a "croupy" character, with slight fever. The palate, fauces, and tonsils became more congested, and the general condition less satisfactory; he got cross, and was restless during the next night, complained more of his throat, and was constantly putting his fingers into his mouth. Next morning he was much worse in all respects, and on examining his throat a spot of membrane was seen on one tonsil . . . . I saw him some thirty-six hours later; the membrane had spread extensively, and the case presented all the signs of typical and severe diphtheria.

HISTORY 5.—Boy, aged 5 years. On the evening of November 13th complained of being tired, and asked to be put to bed. 14th, much the same but more tired. 15th, seen by the doctor, swelling and œdema about the fauces, but no membrane until late in the evening. 16th, much worse; spread of the membrane, with some implication of the voice and breathing; about noon breathing rapidly got worse; a consultant called in, and operation recommended. I saw him at 2 p.m. The tonsils were covered with a thin unhealthy deposit; the arches of the palate were very red and ulcerated in places the uvula was free. The boy's colour was good, while lying quiet.

HISTORY 6.—Girl, aged 6 years. Quite well in appearance on a given day. On the next complained of sore-throat. The doctor was sent for. The child seemed very well in herself, and was playing about the room. She complained of a slight sore-throat. Breathing was normal, as also temperature and pulse. On examining pharynx both tonsils were seen to be enlarged, and on their inner aspect each presented a yellow patch. The doctor saw her again twenty-four (or more) hours later, and learnt that the cough had become croupy during the night, but that, as the child seemed bright and cheerful, they did not think it necessary to send round for him. The breathing, however, was now laboured, the fauces, tonsils, back of pharynx were completely covered with false membrane. Within another twenty-four hours all the symptoms had become more marked; an operation was necessary. Large masses of membrane were feathered out of the trachea and larynx. This proved a most malignant case; the wound became sloughy, and acute phlegmonous inflammation spread all round the neck and extended to the chest. The child died five days after operation with symptoms of profound blood-poisoning.



HISTORY 7.—Girl, aged 6 years. Was attending school until eleven days ago, when she “did not seem well.” She complained of a sore-throat; her voice was not altered, and she could swallow without difficulty. She remained in this condition three or four days, then, as she did not get on, a doctor was called in. He reported that she seemed to have caught cold, but presented nothing definite. Two days later her voice became altered; fauces and posterior pharyngeal wall presented some patches of membrane; the tonsils and uvula were free. When seen by me, three days later, the child’s condition was urgent; the pharyngeal mucous membrane was congested and œdematous, and patched over with small islets of membrane; the tonsils were greatly enlarged, almost touching in the middle line, and presented patches of membrane; the uvula was not implicated.

Subsequently it came out that her twin sisters had been ill about a month previously with sore-throat and a fetid discharge from the nose. They were not treated by a medical man, “as they did not seem very bad.”

HISTORY 8.—Father, mother, baby, and a nurse were all quite well on Sunday. During the afternoon, while sitting in the nursery together, a *very* sickening drain smell was perceived, which lasted about one hour and then passed off. The weather was very sultry and heavy; there had been no rain for a week. The smell was thought to be due to drying up of the water in the drain-traps; the house was a large one, and its sanitary arrangements were modern and believed to be quite good. About the same hour on the following day, the father, mother, nurse, and baby were all taken ill, within a very short time of each other. Sore-throat, swelling of the glands, with pain and tenderness beneath the jaws; high temperature; great lassitude; headache; sweating, were the main symptoms. I saw them on the following day, forty-eight hours after their exposure to the drain odour. The father’s temperature was 104° F., the tonsils were large, and, together with the mucous membrane of the entire pharynx, acutely congested and œdematous, with considerable stiffness of the jaws. The mother’s symptoms were very similar, but less severe, the temperature 101° F. The nurse’s condition was much worse; temperature 104° F., with great prostration; tonsils large, and covered over with white “spots.” The baby suffered least, and was soonest better, diarrhœa being a main feature.

The father and mother recovered after three or four days, not developing any more characteristic symptoms than those

related. The nurse's symptoms, however, developed into characteristic, though not severe, diphtheria.

**HISTORY 9.**—A girl, 6 years of age, who had not been quite as right as usual for a day or two, accompanied her parents one Sunday in autumn on a visit to some friends a few miles from town. She played about all day, and seemed to enjoy herself thoroughly. On her return home she was put to bed and fell asleep as usual. About 3 o'clock on the following morning the parents were roused up; the child was in a violent perspiration, and was gasping for breath; a hot bath was secured as soon as possible, and mustard plasters applied to her chest. The child died between 8 and 9 o'clock the same morning, the doctor arriving just in time to see the child expire. No word was said which gave the doctor any inkling of either croup or other throat affection. I made the *post-mortem* examination, and found the larynx and trachea literally plugged with loosely-adherent, thick, white, false membrane. There were some slight, non-characteristic, catarrhal signs in the pharynx. Subsequent inquiries, even in the light of the *post-mortem* revelations, failed to elicit any symptoms which could have led to a correct diagnosis.

### DIAGNOSIS.

From the foregoing histories it will be seen that the diagnosis of diphtheria is quite easy in many cases, but quite impossible, during the early stages, in other cases. Symptoms, which under some circumstances appear trivial, assume a special significance in the presence of a known source of diphtheria infection. For instance, if in a family of which one member was suffering from diphtheria, another member began to be feverish and languid and to complain of "sore-throat," such symptoms would doubtless attract very much more attention than if diphtheria were not present. Again, if several members of a family, or if several children in a school began almost simultaneously to suffer from "sore-throat," such a symptom would mean a great deal more than if only a single case

of sore-throat were to occur. The difficulty lies in adequately recognising and appraising such symptoms when they occur sporadically and when there is nothing obvious to lead one to suspect diphtheria.

The chief clinical lesson to be learnt is the value of strict isolation and of precautionary measures in cases of a doubtful nature occurring among young people, in whom diphtheria and other zymotic diseases are most prevalent. And what I have said of diphtheria applies to scarlet fever, to measles, to whooping-cough, to smallpox, more or less, in proportion to the relative frequency of these diseases and their relative infectivity. A few days' isolation will ordinarily suffice to settle a doubtful case, and if it prove a false alarm, no great harm comes of the extra care which has been exercised.

In the early stage of many cases which finally prove to be true diphtheria, even the most experienced diagnostician may go wrong. Measles may be suspected for a time, and diphtheria declare itself, and cases which look like diphtheria may prove, after all, to be scarlet fever.

I have once or twice seen stomatitis mistaken for diphtheria. In the former, however, the patches are multiple, sharply defined, they occur all over the mouth, and on the tongue and gums, places in which diphtheria occurs but very rarely, in this country at least. I have twice seen a retropharyngeal abscess mistaken for "croup." In one of the cases, there were signs of catarrh in the pharynx which quickly yielded to appropriate treatment, after the abscess had been evacuated.

In laryngeal diphtheria, the diagnosis may sometimes lie between this and other diseases peculiar to childhood. I take the following table of the differential diagnosis of such conditions from ASHBY and WRIGHT'S admirable treatise on the 'Diseases of Children.'

<i>Laryngismus: spasm of the glottis.</i>	<i>Spasmodic laryngitis (false croup).</i>	<i>Membranous croup (true croup).</i>
Occurs in rickety children under 18 months of age.	Rarely occurs under 2 years of age, commonest 2—7 years.	Occurs at all ages during childhood.
No fever, no coryza, or laryngeal catarrh.	Slight fever, mostly coryza and laryngeal catarrh.	Variable amount of fever, and perhaps some diphtheria in the fauces.
Occurs at any period of the 24 hours, and often many times.	The attack occurs at night.	Mostly worse at night.
No cough, inspirations are stridulous.	Metallic cough, stridulous respiration, variable dyspnœa.	Metallic cough, stridulous respiration, progressive dyspnœa.
Contractions of the limbs, or general convulsions, not uncommon.	Convulsions rare.	Convulsions rare.
The attack lasts a few seconds, and frequently recurs.	Attack passes off in an hour or two.	Becomes steadily worse, though variations occur in its progress.
Occasionally fatal.	Rarely fatal.	Very often fatal.

#### SOME FEATURES OF THE DIPHTHERITIC INFLAMMATION.

The local conditions present all degrees of intensity, and vary from day to day. The diseased parts are usually swollen and infiltrated, and have an œdematous appearance. This infiltration involves the mucous membrane and submucous tissue to a variable extent. Within a short time of the commencement of the disease the well known and almost characteristic "false membrane" appears on the parts, and is the special feature from which diphtheria derives its name ( $\Delta\iota\phi\theta\acute{\epsilon}\rho\omicron\nu$ , a pellicle).

Instead of large patches of membrane, more or less



covering the pharyngeal mucous membrane, we may see only small islets, or even only a few "spots" corresponding to the orifices of the mucous glands. This latter is often the early condition in which the tonsils will be found, —so-called "spotted throat," one of the many names under which diphtheria has been described. The soft palate is very commonly affected, especially on its posterior aspect, and along its margins to the tip of the uvula.

The membrane differs in thickness, in consistence, and in colour; it is "sometimes as soft as cream, and sometimes resembles wash-leather" (JENNER). In some cases of sthenic membranous "croup" the false membrane is white in colour, firm, and thick, free from odour. In cases of malignant diphtheria it may be almost diffuent, offensive, ashen gray in colour, difficult to raise up in pieces, while between these two conditions every intermediate grade is possible.

This membrane is quite insoluble in water, but it readily dissolves in weak solutions of the alkalies. If pieces of well-formed membrane be placed in test-tubes, severally containing a solution of saccharated lime, of sodium carbonate and of potassium carbonate, and some distilled water, very marked differences in result will be obtained. The lime solution will quickly dissolve the membrane; the sodium and potassium solutions will also dissolve it, but less rapidly; while the distilled water will have no effect at all, even after two or three days. The use of solvents in the treatment of diphtheria will be alluded to further on.

Membrane is usually very adherent in the pharynx and in the larynx above the glottis. In the trachea and larger bronchi it is looser and more easily detached, probably owing to the smaller amount of submucous tissue in these parts. Doubtless, too, when the inflammation is very acute, and the ulcerative process beneath marked, the



membrane is thinner, less adherent, has a more gangrenoid appearance, and a more fœtid odour.

The amount of fœtor varies; it is characteristic of gangrene rather than of diphtheria: the greater the amount of sloughing, the more marked the fœtor. In doubtful cases, if fœtor were present, I should count it as a point in favour of diphtheria. In most of the cases of nasal diphtheria, fœtor is a marked feature. But unmistakable, if mild, cases of diphtheria may occur, in which there is little or no fœtor.

Beneath the membrane there is always a certain amount of ulceration; it is less clearly defined than the membrane itself, for there is no line of demarcation between the affected and the healthy parts in the early stages; when such a line of demarcation appears, it is a favorable sign and indicates an arrest of the ulcerative process. The secretion from the ulcerating surface is very acrid and infective; extension of the disease both locally and towards the air-passages is largely brought about by the trickling-down or the sucking-in of this infective material. The amount and intensity of the ulceration are a measure of the intensity of the disease itself.

In my own experience this ulceration is rarely very deep, and the loss of substance in cases which recover is thus often remarkably small. BRETONNEAU refers to this, and regards it as a peculiarity of the diphtheritic ulceration. Other authors, both German and American, have, however, recorded perforation of the palate with considerable loss of substance. Such descriptions are doubtless correct for the particular cases. In this country the type of disease is less severe as a rule, and destruction to this extent is fortunately rare.

In his monumental work on the Pathogenesis of epidemic Diphtheria, Professor OERTEL teaches that the essen-

tial effects of the virus fall on the cells, and consist in minute molecular changes in the cell nucleus . . . .

“The essential and characteristic lesions, as distinct from the concomitant and sequential, are those of cell change. These necrobiotic processes are initiated in the leucocytes and larger round cells that so early appear in the effected tissue. Necrobiotic areas are met with in the epithelium of the respiratory mucous membrane, in the substance of that membrane, in the tonsils, in the mucous membrane of the fauces, uvula, epiglottis, larynx, and trachea; in the cervical, submaxillary, and bronchial glands; in the follicular and agminate glands of the intestine; in the mesenteric glands; in the spleen. But in their extent they vary in these different situations, apparently in proportion to the amount and intensity, as well as to the continuance of the operation of the virus that induces the change. Everything points to the infectiveness of the process, which extends from one part to another in the substance of an organ, or by the lymph-stream, or by the blood, as in the case of the spleen, the disintegrated products furnishing the virus . . . . The conclusion, then, that diphtheria is primarily a local disease seems clearly to follow, for although it has been objected that the intestinal lesions are evidence of general blood infection, yet the amount of change in the intestine points to a diminished virulence there, and the date of these lesions shows that they follow the pharyngeal affection, and may possibly be due to the swallowing of infected products from the mouth and pharynx. This does not preclude the occasional, though rare, occurrence of diphtheria starting primarily from the stomach. As to the lungs, the entire absence in them of any of the characteristic lesions shows that a primary infection of the system through these organs has in no way been proved.

“Diphtheria, then, is a disease in which there is a direct infection by the immediate action of the contagium with the epithelium of a mucous membrane, whence the disease spreads, and in a variable time becomes a general infective or systemic disease . . . .

“The nature of the virus is less clear. It manifestly acts upon cells, causing their disintegration and death, and their infected particles cause the disease to extend to other cells; while it seems as if leucocytes and phagocytes convey the virus into tissues, lymph, and blood. The action of the virus on the blood-vessels is seen in the hyaline changes induced in them, in the alteration of their walls, which causes them to rupture readily, thus leading to hæmorrhages. And the unequal distribution of these vascular lesions depends probably upon the greater or less length of time during which the circulation in them allows the infected blood to remain in contact with their walls . . . .

“The secondary inflammatory and degenerative processes—as found in the lungs, heart, liver, kidneys, and in the nerve tissues, central as well as peripheral—occur in varying degrees, and must be due to the blood infection, the amount of virus thus brought into contact with these organs being insufficient to lead to necrobiosis . . . .

“That the virus is due to the presence of bacterial organisms is highly probable, but that it is the product of their metabolism—a ptomaine—is also most likely, since the microbes themselves are almost wholly confined to the surface, whereas the action of the virus is widespread and deep . . . .” (‘Lancet,’ vol. i, 1888, p. 643.)

## COMPLICATIONS AND SEQUELÆ.

Diphtheria, like some other acute diseases, is liable to be followed by certain complications and sequelæ. It can hardly be said that these are pathognomonic, for, more or less, there is no one complication which can be considered as really peculiar to diphtheria. Even the sequela which is most common and most characteristic, viz. the paralysis, is found occasionally after other acute diseases.

Asthenia.—This is a well-recognised clinical feature in diphtheria, which, though sometimes absent, should always be kept in mind by those who have to deal with this disease, especially among the young. Even in apparently favorable cases, asthenia may supervene quite suddenly, and be severe enough to cause death. It would seem to be due to the toxic action of the virus on the system at large. Very probably acting through the nervous system, it must, nevertheless, be held apart from the neuroses, to which reference will be made shortly.

This tendency of diphtheria to be complicated with this untoward condition appears to me to contra-indicate every kind of depressant remedies, such as emetics or blood-letting, once so extensively used. To antimony, as an emetic, I particularly object, and the use of leeches is, I think, contra-indicated for a kindred reason.

Cardiac dyspnœa.—Every now and again cases are met with in which a most distressing and fatal dyspnœa supervenes. Largely connected with the condition of the heart, it is also in a measure pulmonary, the *post-mortem* characters being clotting of the blood in the right ventricle extending into the pulmonary artery, and softening of the heart-muscle. Whether the clotting is primarily a blood condition due to the diphtheritic virus, or results



from stasis associated with the myocarditis and gradual loss of power to propel the blood, or whether it is a combination of the two causes cannot be directly settled.

In such cases the chief symptoms are rapid breathing and a sense of suffocation ; the patient sits up and gasps for breath ; there is no difficulty in inspiration, but little or no relief from it ; the face is of a leaden hue ; the mucous membranes are pale and bluish ; the extremities cold and clammy. The attacks are strangely spasmodic, of longer or shorter duration, and very distressing to witness. It is more than doubtful whether tracheotomy in any way relieves such a condition. The treatment can, at best, be but palliative—hot turpentine stupes, friction of the hands and feet, and as much fresh air as can be got into the sick-room.

Albuminuria.—I copy the following from Dr. JOHN ABERCROMBIE's brief but admirable account of the subject. He examined the urine in ninety-one cases of diphtheria, which passed under his own observation : albumen was found only in twenty-four cases.

Of the ten patients in whom the urine became albuminous after they came under observation—in one the albumen appeared within twenty-four hours of the onset ; in three not until the tenth day of the disease ; in the others it appeared between the fifth and eighth days.

Judging from the cases where albuminuria was present when the patient first came under observation, it is evident that it is usually developed early in the disease, and its appearance so late as the tenth day must be looked upon as rather exceptional. Albuminuria does not, as a rule, last for long ; in one case it only lasted two days, and in no case more than a fortnight. In no case was any anasarca observed, nor was the urine ever smoky, though a few blood-corpuscles with epithelial and blood-casts



could be seen under the microscope. Dr. ABERCROMBIE has never seen any symptoms of uræmia. Examination of the kidneys after death revealed the ordinary changes of acute parenchymatous nephritis.

. . . Of the twenty-four patients, in whom albuminuria was discovered, no less than fourteen died : whilst of the sixty-seven in whom there was no albuminuria, eight died. So that it is evident that the danger to life is much greater when there is albuminuria than when there is not ; but it is also evident that freedom from albuminuria is no guarantee that the patient will recover.

The late Dr. HILTON FAGGE in his ' Principles and Practice of Medicine ' says : " The urine is not only scanty and high coloured, as in other acute diseases, but it very commonly contains a considerable quantity of albumen. This fact, which was first pointed out by Dr. WADE, of Birmingham, in 1858, is of great value, as sometimes aiding in the diagnosis of cases that would otherwise be obscure. There may also be epithelial and hyaline casts ; and much more rarely, blood. EBERTH is quoted as having found albuminuria present in two cases out of three : but the proportion seems to vary in different epidemics. In some patients it is observed within a day or two from the commencement of the disease : in others not until convalescence already seems to be established. It is sometimes very transitory, and may be detected only once or twice, even in cases in which the urine is repeatedly examined ; but it more often lasts for a week or two. It is generally supposed to be devoid of prognostic significance ; but OERTEL, although he admits that the urine of some patients, who die rapidly, contains very little albumen, yet says that he has been able to make out a close relation between the quantity of this substance excreted in the twenty-four hours, and the general intensity of the

disease. From one to three drachms was the amount usually passed in cases so severe as to threaten life, or to terminate fatally : and the albuminuria persisted, in those who recovered, for six or eight weeks after the subsidence of the diphtheritic affection of the throat . . . .

A few instances of general anasarca have been recorded by different observers, one, for example, by OERTEL in the 'Deutsches Archiv' for 1871. But when this writer speaks (in 'ZIEMSEN'S Handbuch') of fifty fatal cases, mostly attended with suppression of urine and dropsy, as having occurred in Kiel and the neighbouring villages, the doubt arises whether the epidemic was not really one of scarlet fever with diphtheritic complications."

I do not think I can add anything material to the foregoing accounts quoted from ABERCROMBIE and FAGGE. They accord entirely with such observations as I have made personally. In view of the remarkably slight changes, which I have found on microscopic examination of some kidneys after fatal diphtheria, in which albumen had been present during life, I have wondered whether the albuminuria may not sometimes depend on a disturbance of the renal mechanism due to altered nerve influence, instead of on disease of the secreting structures. Such a view would best explain the varying amount of albumen in some of the cases and the rarity of those later sequelæ which differentiate diphtheritic from scarlatinal albuminuria.

Nephritis.—As an exceptional occurrence I may relate the following case. About three years ago I was asked by a brother practitioner to see his little girl aged three and a half years. For a few days she had experienced pain before and while passing her water, but there was nothing abnormal in the appearance of the water. The day previous to my visit, however, the water was smoky,

and then all at once she passed a small quantity containing a considerable amount of blood ; this was almost like port wine in colour. The quantity of urine passed had been small for some days.

When I saw her, her general condition was fairly good. She was pale, rather pasty, and there was some slight cedema about the face, especially about the lower eyelids. On pressure there was slight pitting over the shins. The heart appeared normal. The urine was found to be of a dark red colour, scanty in quantity, loaded with epithelial and blood-casts, and no uric-acid or other crystals ; no mucus. After getting rid of all gross particles by filtration one sixth of albumen was obtained on boiling.

My services had been sought in the belief that there was calculus, either in the kidney or bladder or urethra. I failed to detect anything of the sort. On inquiry, however, I learnt that "sore-throat" was epidemic in the house at the time, and that this little girl had herself just recovered from a mild attack of follicular tonsillitis. She quite recovered in a few weeks. I have no sort of doubt that this child was suffering from a severe nephritis, the origin of which was connected in some way with the epidemic sore-throat. I have seen two or three other, though less marked, cases of the kind.

Multiple synovitis ? pyæmic.—I have recently had under my care in the hospital two cases of diphtheria complicated with multiple synovitis. The first case was a girl aged seven years. The diphtheria came on gradually, following an attack of measles which had occurred about six weeks previously. One of the most marked features throughout the illness was severe and persistent vomiting. Towards the end of her illness her knee-joints, her elbow-joints, the phalangeal joints, and one hip-joint became painful and swollen, and ultimately full of

fluid. The girl died on the seventeenth day of her illness. At the *post-mortem* examination these joints were found to contain pus; the cartilages were not involved. The kidneys were pale and swollen; there had been as much as a quarter of albumen.

The second case was also a girl aged seven years, and occurred within six weeks of the former one. This girl was admitted with symptoms suggestive of renal or vesical calculus. Within nine days she developed diphtheria. The glands at the angles of the lower jaw were very much swollen and very hard. Suppuration occurred subsequently in the peri-glandular tissue. On the fifteenth day pain and swelling occurred in the wrists and in the metatarsal joints. On the dorsal surface of the third right metacarpal bone a distinct fluctuating swelling occurred. The affected joints were tender, and the surface flushed. The case proved fatal, but an autopsy could not be obtained. I have little doubt, however, that, as in the former case, pus was present in the affected joints.

DISEASE OF THE MIDDLE EAR.—I have only once seen this complication, though I have heard and read of its occasional occurrence. In such cases the inflammation travels up the Eustachian tube, and so reaches the tympanum. In my own case, a boy aged four years, the diphtheria was naso-pharyngeal and not of a severe type; the ear symptoms were acute and destructive. When I last saw the child he was quite deaf on the affected side.

ANÆMIA.—In a certain number of cases diphtheria is followed by a condition of anæmia, which is often very persistent and intractable. I have not recognised any features which are characteristic, or which would differentiate the anæmia of diphtheria from cases due to other causes. In two cases in which I examined the blood there was a great disproportion between the coloured and the



colourless corpuscles. This disproportion was due to a deficiency in the coloured, and not to an increase in the colourless, corpuscles.

### EFFECTS ON THE NERVOUS SYSTEM.

These may be divided into (1) The Immediate, and (2) The Remote.

1. The Immediate effects occur during the height of the disease, and are in direct relation to the intensity of the poison. Diphtheria is a disease, which pre-eminently attacks parts supplied by the pneumogastric nerve; it is not strange, therefore, that upon the stomach and heart some of the more palpable constitutional effects of the virus manifest themselves.

Vomiting frequently ushers in an attack of diphtheria, and throughout the whole course of the disease stomach troubles are a grave complication; the loathing for food, its repeated rejection in an undigested condition by the stomach after being coaxed down, are so many palpable signs that its nervous mechanism is at fault. After death I have many times found the stomach dilated and filled with hardly altered food.

In one case I remember a most troublesome hiccough persisted for some weeks after an attack of diphtheria.

2. Cardiac troubles are still more frequent and even more dangerous. Among the lesser of these troubles, cardiac irregularities are met with; sometimes slowing of its action, more frequently undue and exhausting acceleration of the beat.

Complete cardiac failure—syncope—is quite a common cause of death. In some cases, this comes on with startling abruptness. Some unusual move or exertion on the part of the patient appears to be the cause in a few cases,



while in others no such or other cause can be made out. I remember visiting a little boy, on whom I had operated three or four days previously; he appeared to be doing very well; the wound was clean, there was apparently no further spread of the disease, and I prognosed a favorable issue to the parents with some confidence. Hardly had I left the house, before he fell back on his pillow—dead.

2. The Remote effects of the diphtheritic virus on the nervous system are the more characteristic and the only ones to which the term *sequelæ* can be at all aptly applied. "Diphtheritic Paralysis" is considered by some authorities as a pathognomonic feature of the disease. It may affect any muscles or group of muscles, though it shows a marked predilection for certain muscles.

It is not a little remarkable that BRETONNEAU never alludes to this sequela in any of his earlier 'Memoires,' and only in 1843 recognised a causal connection with diphtheria. In this country, the late SIR WILLIAM GULL was the first to draw attention to the subject in the 'Lancet,' 1858, in a paper entitled "Lesion of the Nerves of the Neck, and of the cervical segments of the cord after Faucial Diphtheria." Soon after this a variety of Theses, papers, and cases was published, among the most interesting and valuable of which must be mentioned a paper by Dr. HERMANN WEBER, "Ueber die Lähmungen nach Diphtheria," 'Virchow's Archiv für pathologische Anatomie,' vol. xxv, 1862, and vol. xxviii, 1863. AETIUS CLETUS, however, in his 'De Morbo Strangulatorio' (Romæ, 1636), had already long anticipated these authors, and described what was evidently paralysis of the pharyngeal muscles.

The paralysis does not appear to stand in any direct relation to the severity of the diphtheria; it attacks all

ages, but chiefly the young—perhaps because there are more subjects to be attacked. I have known several members of a family to suffer from diphtheria in varying grades of severity, while one member alone has shewn signs of paralysis subsequently. The paralysis has occurred after “sore-throat” of so mild a character, that its specific nature was only first suspected after the paralysis had developed itself. It must, however, be remembered that a kindred if not identical form of paralysis is known to occasionally follow other forms of acute disease; time alone will show what the exact relation of such a sequela really is to the diphtheritic virus.

Among recent accounts of the condition, that by Dr. ABERCROMBIE, communicated to the International Medical Congress in London (1881) containing the history of eighteen cases, very carefully observed and noted by himself, appears to me to give an admirable and an accurate account of the disease. I have accordingly made free use of his data, and take this opportunity of expressing my obligations to the author.

Dr. ABERCROMBIE writes, “The onset of the disease is always gradual and insidious; it is difficult, therefore, to fix with any degree of accuracy the earliest date at which the paralytic symptoms were noted.

“Excluding cases where thickness of speech was said to have persisted from the commencement of illness, I find that in two cases the paralytic phenomena appeared in two weeks from the onset of illness, and that in four cases they were not observed until five weeks from the onset; the other cases occurred between these limits.

“In fourteen of the cases the earliest symptom was either nasal voice, return of fluids through the nose, or some difficulty in swallowing. In the remaining four, weakness in the legs was the first thing noticed.

“In the majority of cases the order of symptoms is much as follows: Thick and nasal speech, cough when drinking, return of fluids through nose, weakness in legs, back, and arms. Occasionally, however, this order is almost exactly reversed. . . .

“The only constant symptom was paralysis of the soft palate, which was present in all the cases. In twelve the soft palate was ascertained to be anæsthetic; in some of the other cases, the point could not be determined.” . . .

Among the muscles, or groups of muscles, which may be attacked, the most important are those of the chest-wall. Dr. ABERCROMBIE regards this condition as the most formidable that can arise. He reports ten cases:—“in one of the patients who had had for some days paralysis of his intercostals, the diaphragm was paralysed for twenty-four hours, the patient breathing by the aid of his neck muscles alone. This patient was the only one of the ten who survived.”

In paralysis of the limbs groups of muscles, or a single muscle of a group, may be affected; more rarely the entire limb, and still more rarely both limbs, may be affected. The muscles of the trunk appear to be less frequently affected than those of the limbs; among the most frequently attacked are the posterior muscles of the neck, viz. those which support the head. I have had two cases under my care in which the prominent symptom was falling forward of the head, and inability to raise it, the chin resting on the upper piece of the sternum.

The bladder and rectum (sphincters) occasionally participate. One of my cases suffered from incontinence of urine for six months after an attack of diphtheria.

Another, though uncommon, nervous sequela is loss of smell and also of taste, by which latter I mean the perception of flavours by taste. As a temporary condition I

have seen this in three or four adults, and in one at least as a permanent condition. Whether it is more common than my own experience would seem to warrant I cannot say, for a great majority of my patients have been young children, in whom it is very difficult to investigate such a point.

In my own practice the paralysis has invariably been found to have followed the milder forms of diphtheria, and has sometimes been the first symptom (of diphtheria) to be noted. Is a possible explanation to be found in the lack of treatment which mild cases get, and can the vigorous local treatment which BRETONNEAU always enforced and practised, be credited with the non-occurrence of cases of paralysis in his earlier records? I have never seen or known paralysis supervene in any of my cases of tracheotomy, nor do I remember to have seen it occur in any case treated in hospital from the first onset. In this respect paralysis, as a sequel of diphtheria, resembles nephritis as a sequel of scarlet fever. For nephritis is far more common after mild, inadequately treated, attacks of scarlet fever, than after severe attacks, which generally secure early recognition and careful treatment from the commencement onwards.

Pathological anatomy of diphtheritic paralysis.—The exact pathology of this affection is not yet understood, nor is it likely to be, until we know something more definite about the *materies morbi* with which we have to deal.

In seven of the nine cases, which proved fatal, Dr. ABERCROMBIE examined the medulla and spinal cord methodically, and the only pathological changes he found consisted in a swollen condition of the large motor cells of the anterior cornua; their margins were ill-defined, and the processes had in most instances entirely disappeared;



the cell contents were granular, and the nuclei had disappeared. These changes occurred in limited areas. At a later stage of the disease, the cells appeared shrunken rather than swollen. No lesion of the white matter of the cord was recognised. The medulla oblongata did not present any appreciable lesion.

I have myself examined the brain and spinal cord in some cases of well-marked paralysis, without finding any constant or characteristic changes that I could recognise. In one case the large ganglionic cells were certainly unaltered; there was some slight softening in the white matter adjoining the anterior cornua, but whether this was due to inflammation or to *post-mortem* changes I was at a loss to decide.

Some observers have described advanced—in fact, destructive—changes in the ganglionic cells of the cord. That the muscles of the pharynx and of the eye suffer most frequently, and that sensation is not seldom affected, are facts, it seems to me, which point to the insufficiency of the theory that the essential lesion lies in the spinal cord. Moreover, in severe cases, and even after long intervals, recovery, when it takes place, is full and complete, a fact which is incompatible with destructive changes in the ganglionic cells in any part of the nervous system.

More recently an attempt has been made to classify diphtheritic paralysis as a peripheral nerve lesion. Dr. BUZZARD has lent the weight of his authority and experience in support of this view. For myself, while feeling the insufficiency of the older view that it is due to a lesion in the spinal cord, I confess that the material evidence of a localised neuritis is even smaller and less convincing. Among the many cases of paralysis I have seen during the past fifteen or sixteen years, I can only call to mind



one or two in whom there was the slightest objective evidence of a peripheral neuritis. On the other hand, the incidence of the lesion, the manner in which groups of muscles have been affected ; the rapid, sometimes sudden, onset without any appreciable preparatory stage ; the comparatively rapid manner in which it has passed off ; the absence of local conditions, such as pain or tenderness, in the majority of cases are points which, in my judgment, tell against peripheral neuritis, and are, I think, in favour of a central lesion.

What should set up a local peripheral neuritis in a small nerve-trunk, in one leg, for instance ? By some it is held that, like other poisons, the diphtheritic virus has a selective power, and so may affect different parts of the nervous system at a distance from the primary local lesion, and they quote other instances, such as the ingestion or the subcutaneous injection of drugs and poisons, which, as is well known, have each their physiological or toxic action. The analogy in such cases is, I think, faulty, for I believe that all such drugs act on brain centres, and not locally on distant nerve-trunks.

In brief, I incline to agree with MENDEL ('Berliner Klinische Wochenschrift,' No. 12, 1885), who appears to think that the condition is due, not merely to neuritis, but that vascular changes also play an important etiological part in the progress of the disease.

#### PROGNOSIS.

"Even in the mildest attack of diphtheria," says Dr. EUSTACE SMITH, "we must be guarded in the expression of our opinion as to the probable issue of the illness." True in general diphtheria, this remark applies with special force in the laryngeal form of

the disease ; for in the latter we have to deal with disease in a vital organ, which may kill in a few minutes by its mere presence. Dr. SMITH's caution ought to be borne in mind in all cases where tracheotomy has been performed, for the relief, which at first follows, is sometimes so great as to make us forget that the diphtheria itself is in no way influenced by the operation, and that unless vigorously followed up, it will almost certainly spread and prove fatal.

It may be conceded that some cases are evidently more serious than others ; that while we may speak hopefully in mild cases, we must obviously be more guarded in the serious cases. The intensity of the lymphatic enlargement is usually in direct ratio to the severity of the disease, and may be helpful in giving a prognosis, favourable or otherwise. The characters of the membrane and its surface relations are not related to the general infection ; but the depth of the necrobiotic process is usually in direct ratio to the intensity of the disease.

The presence of albuminuria must be regarded as an untoward complication. If the albumen appears early and is very abundant, the prognosis must be very cautious.

A remitting and not over-high temperature is a favourable sign ; the opposite condition unfavourable.

A desire for food, and ability to take and digest it, are favourable signs.

Diphtheria commencing in the pharynx, or naso-pharynx, and lasting some five, or seven, or more days, thence spreading to the larynx, is usually less fatal than when commencing acutely in the larynx, and rapidly spreading to both lungs and pharynx. The system appears to get tolerant of the virus ; or perhaps the intensity of the disease has exhausted itself.

When a child rests fairly well, takes its food without

much difficulty, has a quiet pulse and moist skin, we may prognose more hopefully than when opposite conditions prevail. Restlessness, frequent respiration, a weak rapid pulse, a hot dry skin, an irritable stomach, a distaste for food, are very untoward symptoms; when found together, they call for a most guarded prognosis.

In the paralysis which sometimes follows diphtheria, a hopeful, but cautious, prognosis may be given. When death does not take place during the acute stage, either through the heart or lungs (diaphragm), the paralysis almost invariably passes off. I should, of course, advise the adoption of measures to prevent wasting during the paralytic stage, such as recumbent gymnastics and massage, fatigue of every kind being avoided. General tonics and change of air will also prove advantageous. The paralysis may last months, or even a year, but, in the end, a very large majority of the total cases recovers completely.

## CHAPTER III.

### TREATMENT—PROPHYLAXIS.

*Rest in bed—Stimulants—Diet : milk, “drinks,” beef tea, broths, jellies—Nasal feeding—Drugs—Local treatment—Pharynx—Nose.*

*Prophylaxis : Disinfection of excreta—How to disinfect a room—Duration of infectiousness.*

#### DIET, &c.

In deciding on treatment, we must be guided not only by the general symptoms present in any given case, but by our experience also of former cases. As has already been pointed out, all forms of diphtheria tend to the production of asthenia. Hence treatment of a case, however slight it may appear to be, must be such as will help to ward off this danger.

Rest in bed.—I am sure that one of the most effectual means to ward off dangerous complications is to keep patients in bed, and as recumbent as possible. In cases of any severity a period of fifteen to twenty-one days is not too long during which to enjoin complete rest in bed. The danger of kidney complication, and the peculiar paralysis which sometimes follows, are both less likely to occur in cases that are kept warm in bed. Where the heart shows definite signs of failure, the patients should be kept strictly recumbent, and should be rolled over by the nurse, when circumstances require, in preference to being raised up.

**Stimulants.**—In all stages of the disease a little good brandy is an excellent medicine. One teaspoonful for a child of four years, every three or four hours, is as good a tonic as any drug I know of. It should, however, be really good and old. In the convalescent stages, and especially when the appetite flags, good port or Madeira wine may be given in rather larger doses, more or less according to the circumstances and needs of the particular case. Should the heart show signs of weakness, the wine or brandy must be given more freely.

Brandy mixture of the Pharmacopœia is a pleasant mode of giving a stimulant and a food combined. The number of eggs, as well as the quantity of brandy, can be altered at will.

**Food.**—The importance of careful feeding during all stages of the disease can hardly be over-estimated. In the early stages, and, indeed, throughout the illness, food should be given in its most digestible form, and in as systematic a manner as possible. The stomach function is weakened by the disease, so that in some cases partially-digested food must be tried.

Milk appears to be a very bland and simple kind of food ; it should be remembered, however, that it becomes almost solid after reaching the stomach. It is less objectionable when combined with lime water, or with barley water, or oatmeal gruel, either of which alters its coagulating properties. Or it may be warmed, sweetened, and flavoured ; then converted into curd and whey by the addition of a little essence of rennet. If the curd, or a portion of it, be subsequently well beaten up with the whey, a semi-solid food of great physiological value is obtained. I have known many children, who were said to be unable to take milk food, thrive on milk when given in this manner. But I must also confess that in a few



instances the curd of milk, in whatever form administered, cannot be tolerated.

Custard, chocolate, tapioca, or vermicelli puddings are admirable milk foods, especially useful during convalescence, and may be given along with red or black currant jelly, or with jam, or the pulp of baked apples.

When there is much fever and thirst, milk itself is just one of the things least adapted as a "drink." On the other hand, whey is excellent, since it contains both the watery and the saline elements, which fever patients so largely require. When needful whey may be iced. Whey is easily made, by heating milk just short of the boiling point, and then adding a wineglassful of good sherry. The sherry whey, which remains after straining, can be given almost *ad libitum* as a drink; or it can be slightly thickened, if desired, with isinglass, or cream may be added, or it may be mixed with fruit juice.

Other "drinks" can be made by boiling red or black currant jam or jelly for a few minutes in water, and straining. They constitute excellent and agreeable febrifuge drinks. Lemons may be treated in the same way to make lemon tea; sugar can be added to taste.

Beef tea.—When well made, beef tea is an excellent and indispensable food for the sick-room. To get the full benefit out of the meat, it should be treated somewhat as follows:—After being cut up into shreds, and slightly salted, the meat should be placed in an earthenware jar, covered with cold water, and allowed to infuse over night. The fluid is then to be expressed; the meat is next to be treated with an equal quantity of boiling water, and infused at the boiling point for a further period of twelve hours, and again thoroughly drained. The two infusions should now be mixed together, and after warming (from about 135° to 140° F.) may be given in stated quantities.

In this manner the albuminous constituents of the meat are secured, and a more nourishing and digestible beef tea obtained than by any other method. The tea can be flavoured to taste, either with a few cloves, or an onion (or both). Nicely browned bread crumbs soaked in beef tea make an agreeable change.

Mutton, veal, or chicken broth can be advantageously substituted when a patient begins to weary of beef tea. Well made, all these broths are jellies while cold, and if a patient show any preference for them in this condition, they may be safely given. Home-made calfs'-foot jelly is an excellent and most agreeable food. It can be flavoured either with fruit-juice, lemons, or spices. The jelly bought in shops, being made chiefly from gelatine, has little nutritive value.

At almost all stages of the disease soft solid food, such as jelly, is more easily swallowed than liquids, and is less likely to get into the nose or larynx. Raw lean meat is found useful in some cases on this account. The meat must either be scraped into a pulp, or pounded in a mortar; a little salt should be added. Some children will not take it without sugar or jelly. Either alone, or combined in this way, pounded meat has a high nutritive value.

When, from paralysis or inflammatory induration about the epiglottis and its ligaments, food finds its way into the larynx, or if a patient cannot be got to take food otherwise, it must be administered through a tube, and must then, of course, be liquid.

The simplest plan I know of is the one long practised by Mr. BATTAMS, while Resident Medical Officer at the Children's Hospital, Shadwell. A soft catheter, attached to a glass syringe, is passed through the nose into the œsophagus, and a stated quantity of the necessary food

is then introduced. This is repeated at intervals as long as may be considered necessary. If the nose should prove very sensitive, it may be painted with a small hair brush and a few drops of cocaine solution. But children make little resistance after the first time or two if the proceeding is gently carried out. I shall refer to this subject again later on, when speaking of the management of cases after operation.

Articles of food ought not to be kept in the sick-room, and in sight of the patient. Food should be kept under cover and in ice, and warmed in small quantities as required. Milk is especially liable to undergo putrefactive changes in a hot sick-room.

#### GENERAL TREATMENT.

Drugs.—I do not know of any drugs which exercise a specific action on the course of diphtheria. The main indication throughout the disease is to keep up the patient's strength, and nothing is so likely to succeed as good food. Food, then, is of paramount importance, and drugs occupy quite a second place.

In the early febrile condition five to ten grains of the salicylate of sodium in half an ounce of water every three or four hours will be found useful. I have seen some cases, suspiciously like diphtheria, yield to this treatment, and cease to further develop. The drug is usually well borne by the stomach, but its use must be carefully watched. If it seem in any way to depress the patient, or if it does not seem to do good, its administration must be stopped.

Quinine in doses from one to three grains, dissolved in a little acidulated water, is another febrifuge of great

value. It may be combined with two to four minims of the acid solution of arsenic, or with a few minims of the tincture of perchloride of iron. Such a combination is very useful in the later stages, and during convalescence. The iron requires careful watching, for in some children it proves an irritant both to the stomach and intestines. If tolerated, however, iron is an excellent tonic in such cases.

When there is much obvious depression a few grains (2—3 grains) of the carbonate of ammonia will be found useful. Combined with two or three minims of the tincture of chloroform, and a little syrup of tolu, children take it well.

If, in the beginning of the disease, the bowels are constipated, calomel, followed by castor oil, is the best remedy. Two or three grains of calomel, and a teaspoonful or two of castor oil in two or three hours, will generally promote a free evacuation without pain or irritation. Some practitioners pin their faith to small and frequently repeated doses of calomel as an alterative. I must confess that I have seen good results from its use in a few cases. Half a grain three times a day, with a little sugar of milk, is a convenient mode of administration. As a rule, purgatives must be avoided, for there is a tendency to diarrhœa in the majority of cases.

If there is much restlessness, or any inclination to laryngeal spasm—which may occur without diphtheritic affection of the larynx—bromide of ammonium in doses of three to six grains will be useful. It may be combined with spirits of chloroform, or glycerine, to disguise its taste.

Emetics.—I do not regard with favour the use which is, even now, too frequently made of antimony in the early stages of the disease, chiefly in the laryngeal form. I



especially object to its repeated and continued use. Not infrequently children have been reduced to a state of exhaustion by this drug, from which it has been impossible to rouse them. Its only possible beneficial action is one common to all other emetics, viz. a purely mechanical one, detaching the membranous exudations by the retching and vomiting to which it gives rise.

Antimony, moreover, frequently fails as an emetic in cases of diphtheria; the toxic action of the special virus and the resulting constitutional depression interfere with the physiological action of the drug. Then, later on, or when tracheotomy has once more re-established the vital function, the ingested antimony commences to be absorbed, and to produce the baneful influence it so largely possesses.

Emetics have, no doubt, rendered good service in some cases. It is, however, well to select those which act as emetics only, and not as depressants. I have found sulphate of copper as good as any, if not, indeed, the very best. It is rapid in its action, and the local effect on the pharynx is not without its value. Dr. RINGER, in his work on 'Therapeutics,' says, "a good way to give this salt is to administer it in small and frequently repeated doses. It generally produces one copious evacuation, neither purging, nor producing nausea or prostration." I usually order sulphate of copper, five grains in one ounce of water, and give a teaspoonful every ten minutes until vomiting ensues. If this does not produce the desired effect, give some warm water, and if this also fails, irritate the pharynx with a throat brush or a feather.

But whatever drug be selected, effort must be made to secure its emetic action. Copper is an irritant poison if retained, and therefore vomiting must be produced by other means if the copper alone fails.

Warm baths, also, are indicated; they are soothing,



and promote the action of the skin. It is better to repeat than to prolong the bath ; five minutes suffice. When possible, a large bath and plenty of water should be used, so that the whole body can be plunged in at once.

#### LOCAL TREATMENT.

Pharyngeal diphtheria.—If the manifestations commence in the pharynx, the first and most important measure to adopt is some local application to the diseased parts. In my judgment, strong hydrochloric acid is far away the most efficacious. It was first and largely used by BRETONNEAU, and subsequently by TROUSSEAU, who says of this drug, that it is one of the most energetic topical applications we can use. It can be applied fuming and pure three or four times in the twenty-four hours, “ sans avoir rien à en redouter.” In modifying diseased surfaces it has the advantage over sulphuric and nitric acids of not penetrating deeper than nitrate of silver.

In using it, I have always diluted the acid with about twice its bulk of glycerine, applying it freely and systematically once or twice at intervals of twelve or twenty-four hours, according to the effect produced. It appears to act favourably, as BRETONNEAU taught, by substituting a simple for a special and malignant form of inflammation.

In addition to this, it is very essential to frequently swab out the pharynx and free it from secretions and exudations, which otherwise tend to accumulate, and which, being infective, rapidly involve neighbouring parts with which they come in contact. Glycerine of boric acid is an admirable application, and besides being antiseptic it is non-irritating, and if swallowed does not upset the stomach ; it may be applied with a large soft camel's

hair brush every hour, or in severe cases every half hour, until the pharynx assumes a healthier appearance. Glycerine of carbolic acid is also a good application. Recently I have been using resorcin—10 per cent. in equal parts of glycerine and water, and have been gratified with the results.

Dr. WM. MACKENZIE, in 1825, extolled, as almost a specific, nitrate of silver solution (one scruple in a fluid ounce of distilled water). He recommended the solution to be freely applied once or twice a day with a large camel's hair brush; it is to be applied "to every bit of the affected parts."

A gargle or spray of lime-water is both simple and effectual, and helps to clean out the pharynx as well as to throw off the false membranes.

Equal parts of glycerine and tincture of perchloride of iron is a good preparation. Equal parts of glycerine and the tincture of iodine have also been used with success by some practitioners.

Dr. POTTER, of Highbury, some little time ago, informed me that he had obtained very satisfactory results without any locally applied remedies; he gave glycerine of boric acid to suck at intervals of one hour.

Insufflations.—Another local application of great

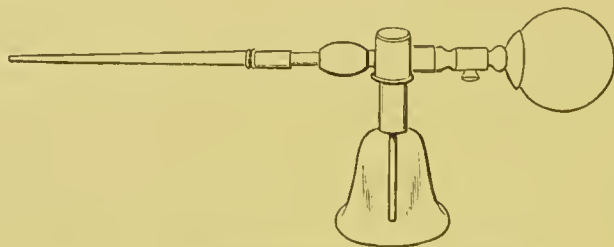


FIG. 1.—A convenient form of insufflator.

value is a mixture of boric acid two parts, iodoform one part, to be insufflated into the pharynx, by preference

after swabbing away any discharge or mucus that may have accumulated. For this purpose the insufflator, figured on the last page, is most convenient. It may be used two or three times a day. Insufflations may also be made into the nose, through the nostrils, as a precautionary measure.

Nasal diphtheria.—That the secretion from a diphtheritic surface is peculiarly acrid and irritating may be surmised from the excoriation of the anterior nares and upper lip seen in cases where the nasal mucous membrane is much affected. The interior of the nose not being so accessible as the pharynx, it is more difficult to apply local remedies. Perhaps the most effectual method is by means of an irrigator, as recommended by JACOBI and other authorities; any of the foregoing formulæ



FIG. 2.—An arrangement for irrigating the nose.

suitably diluted with water can be used. In severe cases I have not hesitated to anæsthetise a child, in order to

save struggling and subsequent exhaustion, and to be sure of a thorough removal of the discharge. An arrangement as in the woodcut on p. 65 is a convenient way of applying irrigation. If the patient is old enough, nothing is simpler; on the other hand, few things are more troublesome if the child resists.

Warm solutions of carbolic acid (1—500), or of boric acid, or of borax (3—5 per cent.), or of perchloride of mercury (1—2000) or some other disinfectant, or a simple solvent such as a weak solution of potash (3—5 per cent.), may be used. The irrigator should be raised very slightly above the patient's level, in order not to have too strong a current; the tube is inserted into one nostril, while the child's head is held forward and downwards, and from one pint to two or more pints of the fluid are slowly and gently passed through, the course of the current being changed two or three times. If the head is held properly, the fluid passes into one nostril and out of the other; the mouth should be kept open.

Value of a spray.—Various disinfectants may also be sprayed into the throat or nose. A convenient manner of holding a child is shown in a drawing on page 114. Whenever it is practicable, a steam spray should be used; the fluid is more finely pulverised and can be more effectually inspired. In cases where the *foetor* is very pronounced, solutions of carbolic acid (2 per cent.), or of corrosive sublimate (1—1000), or of sulphurous acid may be sprayed into the mouth, and inspired through the nose. Solutions of carbonate or of borate of soda will also be found of great value in cleansing the mouth.

TROUSSEAU taught that mercurial preparations, whenever they could be applied locally, most powerfully modified the diphtheritic inflammation, and for this purpose he used both calomel and the red oxide. I have not had



sufficient experience of them to allow me to speak of their value.

I do not think, however, that the particular drug is a matter of first importance ; success depends rather on the manner in which the application is made, and on the thoroughness with which the diseased surfaces are reached and the infective products of the disease got rid of. BRETONNEAU used to lay great stress on the value of local treatment both in pharyngeal and nasal diphtheria. In the latter he recommended the injection of a strong solution of nitrate of silver. "I have always found," he says, "local applications efficacious when I have been able to carry them over the whole extent of the diseased surface."

There is, however, one point on which to insist in making any of these local applications :—Violence must be carefully avoided ; and especially let me warn against that form of violence which manifests itself in the forcible removal of false membrane.

#### PREVENTIVE MEASURES.

General instructions.—When diphtheria occurs in a family, prompt isolation of the affected person is imperatively indicated, and by the recent Act of Parliament the medical man in attendance is obligated to inform the Medical Officer of Health of the district that the case has occurred. If there be other children in the house, and especially if any of them seem at all unwell, a careful examination of the fauces should at once be made, in order to detect the earliest beginnings (if any) of the disease and secure proper isolation. Such an examination should be repeated from day to day. Dr. WICHMANN, of Copenhagen, during his recent visit to London, informed



me that at the Children's Hospital in that city, where diphtheria usually presents a malignant type, every child's pharynx is systematically examined each morning, in order, should the disease occur, that it may be dealt with at the earliest possible moment.

In a private house, one of the largest and best rooms should be selected for the patient; and if circumstances permit, an adjoining smaller room should also be secured. Carpets, curtains, pictures, trinkets, and all unnecessary furniture should be moved out of these rooms; a water-closet in close proximity is very desirable, so that the secretions can be readily got rid of without the necessity of carrying them through the house. The practice of selecting a small attic room, which is not uncommon, cannot be recommended on any grounds.

The infected person being properly housed and isolated, the next important duty is to make a careful search for the origin of the infection. In doing this it must be borne in mind that the infection may have been contracted outside. Should any glaring unsanitary arrangements be detected they should be temporarily remedied; if the fault appears to be in the water supply, the water should be boiled before using. I strongly deprecate any radical remedial measures being undertaken so long as a patient remains in the house; for to open up drains or water-closets under such circumstances means adding seriously to the dangers incidental to diphtheria. Enquiry will generally elicit whether the family have suffered from infective disease, and for how long. Should nothing of this kind be discoverable, it may be taken for granted that the disease has been contracted outside the house.

Besides isolating the patient and keeping the rest of the family strictly away from him, the use of disinfectants in the house will be advisable. One of the simplest and

best for such a purpose is the burning of sulphur in small and repeated quantities. A small lump may be ignited on a plate, and allowed slowly to burn away; if done carefully a considerable amount will be tolerated without any sense of suffocation.

It would be well also for the inmates of an infected house to wash out the mouth with a solution of boracic acid, or with Condyl's fluid. This is especially useful just before going to bed, in order to dislodge any germs which may possibly have effected an entrance. In adults the use of the tooth-brush will also contribute to efficiency. In the case of young children the mouth and throat may be sprayed, or swabbed out with a throat-brush, a little glycerine of boracic acid being made use of.

An excellent and antiseptic tooth powder is composed as follows:—Precipitated chalk, 1 oz.; powdered white soap, 2 dr.; purest phenol and eucalyptus oil, of each  $\frac{1}{2}$  dr. To be well mixed. This powder, with slight and obvious modifications, will be found useful in everyday life, as well as during epidemics of infectious disease. It is especially recommendable for residents in hospitals, and for nurses in charge of infectious cases. In times of epidemics, or when attending on malignant forms of infectious disease, the mouth should be washed out at frequent intervals throughout the day.

As few persons as possible should have access to the sick-room. In case of death, the usual practice of assembling the family and relatives should be discarded, not only in the interests of the family, but in those of the wider public, among whom the infective material may, most unintentionally, be disseminated.

A basin of disinfecting fluid should stand in some convenient place in the sick-room, so that the nurse, and all other persons having access to the room, may rinse their

hands after touching the patient. For the nurses this is a matter of importance, and may be the means of saving many from auto-inoculation. Nurses should be especially careful to purify their hands before taking food.

Disinfection of excreta, sputa, &c.—The importance of disinfecting all discharges and excreta of diphtheritic patients cannot be over-estimated. It does not suffice to get rid of them simply; they should all be sterilised before being thrown into the drains, otherwise the virus comes to the surface again sooner or later. A solution of corrosive sublimate (1—500) is at once the most efficacious and the most economical means for this purpose. A little of the solution should be placed in the bed-pan before use, and some more added after use, and the two left in contact for a little time before the pan is emptied. Sputa may be disinfected in the same manner, and the urine also.

The bed- and body-linen, before being sent to a laundry, should be soaked in corrosive solution (1—1000 or 1—1500), and should be washed separately from other linen. During the illness all drinking-cups should be kept separate from those in use by the rest of the household. Sponges should not be used: pledgets of corrosive wool wrapped in gauze are far better, and can be burned immediately after use. Pieces of old linen, in lieu of pocket handkerchiefs, should be utilised, and burned after use. Toys, &c., which the patient may have played with, should also be burned.

How to disinfect a room.—Close up the fireplace and all holes and crevices with paste and paper. Then set fire to some crushed brimstone, which has been previously melted in an iron pan (one pound of sulphur is required for every 1000 cubic feet of space), and let it slowly burn away. When well ignited, shut the door of the room,

and paste over all crevices. Leave the room for at least twelve hours. This will effect what Mr. WYNTER BLYTH calls superficial disinfection. This form of fumigation will not spoil anything in the room. Chlorine gas is even more efficient, but exerts deleterious influence on many things. Chlorine is generated by pouring hydrochloric acid on chloride of lime ; the lime should be placed in saucers in different parts of the room. It must be done very expeditiously, for the fumes quickly rise, and are very dangerous if inhaled. Ventilate the room freely afterwards. Then send the bedding, pillows, and such articles to be stoved ; everything that will wash should be soaked in corrosive sublimate solution, 1—1000 or 1—1500, for some hours, and then washed in the usual way. The floor of the room should be freely sprinkled with corrosive solution (1—1000), and then well scrubbed with hot water and soft soap. The walls should be stripped and repapered, or otherwise well rubbed down. The ceiling ought to be limewashed ; the furniture well rubbed with furniture polish containing turpentine.

Duration of infectiousness.—Owing to the uncertainty which prevails as to the essential nature of the diphtheritic virus, our knowledge of the duration of the infectiousness of a case is also a little uncertain. For we have to consider not merely the patient, but his surroundings too. It is far more easy to disinfect the former than the latter, for, as Dr. LEWIS SMITH says, “the diphtheritic virus, like the scarlatinous, may remain for weeks or months in a locality, or in apartments, notwithstanding the use of the ordinary and sanitary measures.”

As regards a patient, much will depend on the thoroughness with which he is looked after during his illness. The period during which a patient remains infectious is a matter of great practical importance, for change of air to



the sea-side is one of the best means for completing and assuring convalescence. The patient, I think, may be considered safe at the end of a week from the last local manifestation of the disease, provided he has been thoroughly washed and disinfected by bathing. But popular prejudices would render it undesirable to think of moving a patient so early. I always recommend that at least one month should elapse from the last appearance of membrane before any change is recommended ; it goes without saying that the general condition must in all other respects be quite satisfactory. In his 'Duration of Incubation and Infectiousness of Fevers' Mr. VACHER says, "I think that fourteen days are a safe maximum."



## CHAPTER IV.

### TRACHEOTOMY IN LARYNGEAL DIPHTHERIA.

*Some Remarks on Tracheotomy—Surgical Anatomy—  
Diameter of Trachea—Ought Chloroform to be given?—  
Instruments necessary—Silver Tubes—Trachea Dilator  
—The Dissecting Operation—The newer Operation—  
Clearing out the Trachea—Trachea Aspirator—Dangers  
during and after Operation—How to meet them.*

THE OPERATION, never an easy one, may be very difficult, and oftentimes has to be performed under conditions little adapted to facilitate its carrying out. Probably more deaths occur during this than any other surgical operation. Nor is this the surgeon's fault, for the diseases requiring the operation implicate a most vital function, and patients come under observation often, not only when all other resources have failed, but when life is all but extinct. It is an operation, moreover, most frequently required in children, in whom the shortness of the neck, and the great vascular engorgement of the parts concerned, add seriously to the difficulties.

Essential indication for operation.—It may be broadly enunciated, and whatever be the nature of the circumstances, that tracheotomy is indicated in all cases

of increasing and persistent dyspnœa, due to mechanical obstruction in the larynx and upper part of the trachea.

Are there any contra-indications?—Can a disease have progressed so far as to justify a surgeon in refusing to operate? This is a question which I will not venture to answer for others; but in any case where mechanical obstruction in the larynx leads to laboured breathing, I hold that tracheotomy will prove beneficial to the patient; it will prolong life even if it do not save it; it will deprive death of one of its terrors by relieving that sense of suffocation—of strangulation—which is absent even in the worst cases of pneumonia, when the larynx is free. As Dr. WEST remarks, “many of the deaths after tracheotomy are, strictly speaking, far from being instances of failure.”

Can a child be too young?—As regards age, it will be remembered that SCOUTETTEN successfully operated on his own child at the age of six weeks in the last stage of croup. The number of successful operations in children under two years is, nevertheless, very small; this number is yet large enough (and increasing) to show that success is possible, and that, therefore, age alone is not an adequate contra-indication.

Essential symptoms of obstruction.—The most reliable symptom of obstruction—and one common to all forms of laryngeal obstruction—is recession of the soft parts of the chest-wall during inspiration. Thus, whenever we see that the epigastrium, the supra-clavicular, suprasternal and the intercostal spaces recede during inspiration, we may be quite sure that there is serious mechanical obstruction to the entrance of air into the chest. And if, with this recession of soft parts, there is more or less alteration or suppression of the

voice, then we may know that this obstruction is situated in the larynx. A further indication of laryngeal obstruction consists in the convulsive movements of the larynx—the so-called “laryngeal excursions.” When obstruction exists lower down, the movements of the larynx are almost normal; but when there is obstruction high up, and especially when it is strictly localised, the larynx will be found to move in quite an unusual manner. It is to arrest these unusual movements that some authors recommend a sharp hook to be inserted in the trachea before opening it.

Frequent breathing is to be carefully differentiated from laboured breathing: the former indicates that a portion of the lung is *hors de combat*; the latter indicates a mechanical impediment to the entrance of the air. If expiration should be as laboured as inspiration we have further proof of mechanical obstruction, for neither paralysis nor spasm will explain this. Tracheotomy will relieve this latter, but not the former condition.

At what stage of the disease should an operation be advised?—It is not easy to specify the exact moment when an operation should be done. If the dyspnoea is very intense, other remedies having failed, there is then no choice but to operate. The question, however, is, should we let our patients get to this stage before we operate? The well-recognised tendency of laryngeal diphtheria to spread to the lung, and the serious nature of this complication when once set up, are strong arguments in favour of an early operation.

The amount of membrane deposited in any given case, as well as of the submucous swelling, and the period of the disease at which they occur, vary very much. For these reasons I have never been able to divide my cases rightly into stages, as the French authors do. I am

guided by the breathing in each case, rather than by any other indication. To the question at the head of this paragraph, therefore, I should reply, that there is no statable period in the disease at which tracheotomy must necessarily be undertaken. It is the effects, rather than the period, of the disease which call for it; the opportune moment must be decided by the surgeon.

In practising tracheotomy when children are about to expire, we run the risk, as TROUSSEAU remarks—"1st, of finding the false membranes occupying a very great extent; 2nd, of not being able to remedy congestion, engorgement, inflammation, and pulmonary emphysema, which are rather frequent occurrences in the last stage of asphyxia; 3rd, the operation is rendered much more difficult in consequence of the enormous swelling of the cervical vessels, the swelling being greater in proportion to the embarrassed respirations." Finally let me add, and endorse, GUERSANT's advice: "The younger the child, the less can we afford to delay the operation."

Bearing in mind the comparative harmlessness of the operation of tracheotomy, and the extremely fatal nature of laryngeal diphtheria, as a surgeon I should prefer to be reproached with having occasionally undertaken an operation a few hours earlier than was absolutely necessary, rather than be obliged to look back on fatal cases, which my hesitation had deprived of help, while there was yet time effectually to render it.

#### SURGICAL ANATOMY OF THE TRACHEA.

Although it is hardly probable that the various structures found in front of the trachea will be individually



recognised during the performance of a tracheotomy, it may be as well just to bear in mind what these structures are.

**FASCIÆ.**—After the skin and superficial fascia we come to the deep cervical fascia, which in this part consists essentially of two layers—the superficial and the deep. The superficial layer is attached to the hyoid bone above by blending with the fascia which attaches the two digastric muscles to this bone. It passes outwards towards the sterno-mastoid muscles, at the edges of which it splits so as to encase them. Below, it again divides into two layers, which are attached to the anterior and posterior borders of the upper edge of the manubrium sterni, enclosing a little angular space, which contains cellular tissue, and sometimes also a gland. This layer covers the anterior surface of the sterno-hyoid and sterno-thyroid muscles. Beneath these muscles comes the deep layer of the cervical fascia, which is attached to the lower border of the hyoid bone. Passing downwards, it encloses the thyroid isthmus, and covering the front of the trachea, it extends into the thorax to join the anterior layer of the pericardium. Laterally it forms the sheath of the great vessels of the neck.

**VEINS.**—The next important structures are the anterior jugular veins, which are very irregular in their course and termination ; they are placed immediately superficial to the sterno-hyoid and sterno-thyroid muscles, and are frequently connected by a transverse branch at the lower part of the neck. Normally there should be one on each side of the median line ; not infrequently one is much larger than the other. Sometimes the left vein crosses over and terminates in the right one. A plexus of large veins surrounds the thyroid isthmus, opening above into the superior thyroid, and below into the inferior thyroid veins. These latter are of considerable size, and one may lie

immediately in front of the lower part of the trachea : they open into the innominate veins. It may be well to remind the operator that, in the child, the left innominate vein occasionally runs above the level of the sternum, and has more than once come into sight during a tracheotomy operation.

In all forms of pulmonary obstruction these veins become greatly distended. Apart from the troublesome hæmorrhage which follows if they are wounded, there is the further risk that air may be sucked in during the patient's struggle for breath.

ARTERIES.—The course and distribution of the cricothyroid, a branch of the superior thyroid, and of the thyroidea ima, an irregular branch either from the aortic arch or from the innominate, are of importance, and must be kept in mind by the surgeon when operating.

In the child, the innominate artery is closer to the left carotid at the lower part of the neck than obtains in the adult. LÜCKE, when operating, once felt this artery beating close beneath his finger, immediately in front of the trachea. HÜTER made some anatomical researches on this point, and found that the innominate not infrequently rises up perpendicularly along the trachea. There are also occasional abnormalities in the origin of the great vessels from the aorta, which may complicate the operation seriously.

MUSCLES.—The chief point to remark is, that the sternohyoid and sterno-thyroid muscles are not quite in contact in the median line. At their upper attachment there is an interval of about an eighth of an inch, and as they descend they gradually get further apart. It is well to remember this fact, as it is a strong argument in favour of making an exactly median incision.

THYROID GLAND.—This gland consists of two lateral masses, united by the isthmus which lies across the trachea.

The isthmus is chiefly concerned in the operation of tracheotomy. Its width varies considerably in different individuals, being generally larger in the female than in the male—a fact which explains in part why its position on the trachea appears to vary. In adults the isthmus usually lies over the second and third tracheal rings; but in children it is almost always higher up, generally on the crico-tracheal membrane and the first tracheal ring. I have not infrequently found it situate over the cricoid cartilage; in one case I dissected it covered the five upper tracheal rings. The various methods of dealing with it at the operation will be referred to elsewhere.

THYMUS GLAND.—This gland is sometimes largely developed and persistent in very young children, and in attempting the lower operation has not only been seen in the wound but has proved an obstacle to the carrying out of the operation.

TRACHEA.—The trachea is exceedingly moveable, and for very obvious reasons, thanks to the large amount of soft cellular tissue by which it is everywhere surrounded. From a surgical point of view this anatomical arrangement is not any advantage, for it permits of the trachea being easily displaced from the median line if the retractors or the sharp hook be unskilfully used during tracheotomy. Moreover, this soft cellular tissue quickly inflames, and affords a dangerous resting-place in which pus and other exudation products are very liable to collect. In the chapter on “Complications” some reference will be made to this condition.

The trachea commences at the lower border of the cricoid cartilage on a level with the sixth vertebra, and terminates opposite the fourth dorsal vertebra, by dividing into the right and left bronchus; the surgical limit of the trachea, however, is at the upper border of the sternum.

The distance from the cricoid cartilage to this spot is about four centimetres (TILLAUX) in a child four years old, and somewhat less in younger children. As the trachea passes down to the chest it recedes slightly from the surface of the neck, so that at the upper border of the sternum its depth is nearly one inch and a half. These points are well shown in Fig. 6, p. 86, which represents a vertical section from before backwards. This direction of the trachea backwards as well as downwards is of great importance in relation to the spot at which the trachea should be opened, and to the shape of the tube which should be inserted afterwards.

The size of the trachea is very variable even in individuals of the same age, and at different ages also. In twenty-four cases taken without selection from the *post-mortem* room, mostly young children, I found the average diameter to be  $\cdot 374$  of an inch ( $9\cdot 350$  mm.). The list included one medium-sized male, aged twenty years, with a measurement of  $\cdot 550$  ( $13\cdot 50$  mm.), which may be taken as a standard of comparison; one boy aged thirteen years, with  $\cdot 475$  ( $11\cdot 66$  mm.); and one girl aged eleven years, with  $\cdot 425$  ( $10\cdot 43$  mm.). The average of twenty cases of eight years and under, boys and girls, gave a measurement of  $\cdot 356$  ( $8\cdot 74$  mm.). These last include an infant aged nine months, with a measurement of  $\cdot 250$  ( $6\cdot 14$  mm.); an infant aged ten weeks, with a measurement of  $\cdot 300$  ( $7\cdot 4$  mm.); a boy aged two years and two months, with  $\cdot 275$  ( $6\cdot 77$  mm.); a girl aged three years and nine months, with  $\cdot 500$  ( $12\cdot 27$  mm.); and another girl with  $\cdot 500$  of an inch ( $12\cdot 27$  mm.). From the foregoing figures it will be seen how considerably the trachea varies in size.

Brief mention may here be made of the great development which the larynx and trachea commence to undergo at and after about twelve years of age; this is out of pro-



portion to that of the rest of the body ; it is more marked in boys than in girls, and has important bearings on the treatment of some of the complications which follow the operation of tracheotomy. After middle life the cartilages of the larynx and trachea show a tendency to ossification ; in advanced life this ossification is often so marked that a saw may be required to cut through them. The cricoid cartilage is the chief landmark. In thin subjects it can be readily made out, but in many young babies, and in children with a large thyroid isthmus, or with much fat, it is not by any means easy to distinguish.

#### PRELIMINARY CONSIDERATIONS.

OUGHT CHLOROFORM TO BE USED?—I have no hesitation in answering this question in the affirmative. After some considerable experience, I can truly assert that I have never seen any ill effects produced by its use. There is, not unnaturally, some little struggling when the inhalation is first commenced ; the child holds its breath, the face and lips become blue and congested, and the veins of the neck get full. But very similar results follow when the operation is done without chloroform, for the pain causes the child to struggle, and it also resents being held in a constrained position.

If the chloroform be slowly and carefully administered, a child may be “sent off to sleep” without any trouble or danger. For this purpose a few drops of chloroform should be sprinkled on a handkerchief or piece of lint ; it should then be held to the child’s face by degrees. Two or three whiffs under these circumstances suffice to make the child drowsy, after which the inhalation can be proceeded with more rapidly. It is the choking

sensation of a large dose of chloroform, suddenly applied, which leads to struggling. At the commencement of the inhalation the child may be allowed to sit up; the enforced recumbent position is generally resisted by children, as it is instinctively avoided by adults suffering from any form of dyspnœa.

Using these precautions I believe that chloroform may be safely administered to children requiring tracheotomy. Indeed, I have more than once seen the respiration become deeper and quieter after a few inhalations, and a state of repose brought about which eminently facilitates an operation, never an easy, often indeed an exceedingly difficult one.

VALUE OF AN ASSISTANT.—By way of preliminary, I would just say that, whenever it is possible, the surgeon will do well to have an assistant with him. It is true that one should be prepared to undertake the operation at any moment single-handed; but this does not lessen the value of a good assistant, whenever it is possible to have one. Considering all the circumstances, there are few operations where skilled help is more welcome than in tracheotomy.

INSTRUMENTS.—It may be as well to say a few words about the instruments. Very few suffice. I think it is desirable to keep them apart in a small portable case, so that they are always ready; for the surgeon is mostly summoned in a hurry, and if he have to collect his instruments, it is not improbable that some one or other may be left behind. Most of the surgical instrument makers keep on hand convenient cases containing all the instruments that are wanted. Another caution I must give: Be very careful to thoroughly cleanse and disinfect them, and the silver tubes, before and after each operation. I

have seen at least one case of infection of the trachea by instruments.

SILVER TUBES.—Of chief importance are the silver tubes ; a pocket knife might be very well used on emergency, and retractors extemporised out of hair-pins ; but the tubes must be carefully made, and cannot be readily dispensed with.

The curve of the tube is a matter of great importance. The ordinary quarter-circle tubes do not correspond with the natural direction of the trachea, and hence their use is contra-indicated on anatomical grounds. This may be seen by reference to Fig. 3, which represents a vertical

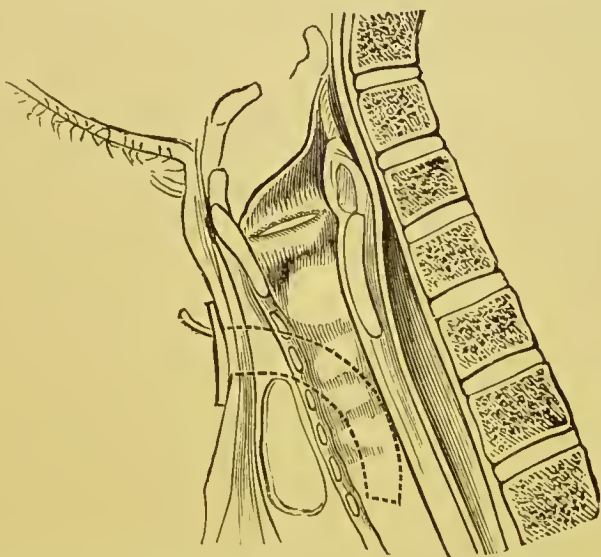


FIG. 3.—Outline figure of the Trachea, showing its direction, and an Ordinary Tube *in situ*.

section through the trachea, with an ordinary quarter-circle tube in dotted outline *in situ*. The lower extremity of the tube tends to impinge on the anterior wall of the trachea, and it will subsequently be shown

that this is attended with many inconveniences, and even with grave risks. The drawing is altered from BRAUNE'S 'Anatomical Atlas,' and its correctness was tested by a preparation which I made, now some years ago, at University College, with the aid of my friends Mr. GODLEE and the late Mr. OTTLEY. In place of these quarter-circles I have devised an "Angular Tube," the shape of which corresponds more nearly to the direction of the trachea. Having now used it for some time past, I can speak with confidence of its value and utility.

For descriptive purposes, a tube may be divided into three parts:—the collar, the cervical portion, and the tracheal portion. The angle at which the cervical joins the tracheal portion constitutes the essential character of the tube. The exact angle and shape are well shown in Fig. 4. Owing to the variations in size and depth of

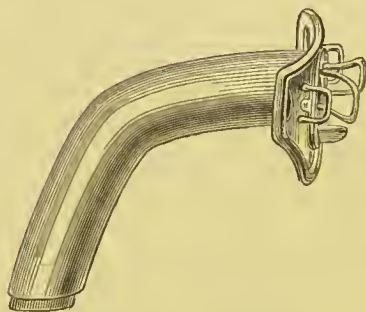


FIG. 4.—Author's "Angular" Tube.

the trachea, to which I have already alluded, and to the amount of swelling which occurs after operation, the surgeon must obviously be provided with a good selection of tubes of various sizes, in order to secure a good fit. Measurements of the trachea have already been given. The series of tubes should accordingly run from No. 18 to No. 30 or higher, French gauge; the most useful sizes for children being Nos. 20, 22, 24, 26, and 28 for the outside cannula.



Of not less importance, however, is the length of the tube, and especially of the cervical portion; for it is this portion of the tube which occupies the parts in the neck most liable to undergo change. A little more or less of the inflammatory swelling, present in nearly all cases, just makes the difference between comfort and discomfort. In ordering tubes, therefore, pairs may advantageously be secured—that is to say, tubes identical in all points except in the length of the cervical portion; and in this respect one tube may be a quarter-inch longer than the other. The trachea itself does not alter its relations, and hence the tracheal portion of the tube is not so liable to cause trouble. Provided the direction of the tube correspond to that of the trachea, a minute difference in its length is of no consequence; for, however long, the tube cannot press on the anterior wall of the trachea and so cause ulceration, as formerly did the quarter-circle tubes.

The inner tube has to be cut away in order to pass the angle. I would recommend in all cases that this be done as little as possible. The annexed drawing shows the extent of this cutting away.

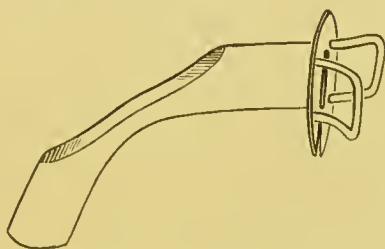


FIG. 5.—Inner Tube.

In recent and acute cases I am beginning to think that it is no real disadvantage; for, as will be seen later on, I recommend that a trained nurse be always at hand, and that no secretions of any kind be allowed to accumulate

within the tube. If this practice be carried out, the need and purpose of an inner tube are almost abolished. In more chronic cases an inner tube is certainly advantageous ; but even then, seeing how readily such secretions putrefy, it is desirable to change and clean the inner tube every few hours. If this be done, my inner tube, imperfect though it may be, answers its purpose very well. The adjoining woodcut shows one of those " Angular Tubes " *in situ*.



FIG. 6.—Outline figure of the Trachea, with the " Angular " Tube *in situ*.

But under any circumstances it is very desirable that the tubes should be as short as possible ; for it is a matter of observation, borne out by Dr. WEST among others, that patients breathe more easily through short than through long tubes : that is to say, given a certain calibre, the muscular exertion required to draw in air and expel exudations is small in proportion as the tubes are short. It is also important that the tubes should not project much in the neck, nor afford any handle that the patient can

catch hold of. I have known a child displace its tube to the imminent danger of its life. The extent to which Mr. DURHAM's and also Mr. BRYANT's otherwise excellent tubes project is a drawback to their use for young children.

Like Mr. HOWSE,\* though for a different reason, I recommend the largest sized tube that can be got into the trachea without violence and the shortest which is consistent with safety. BRETONNEAU's precept was that the tube "should have at least the normal diameter of the glottis of the subject." "I have become thoroughly convinced," he says, "that, in the last stage of malignant angina, the success of tracheotomy depends upon the amplitude and the freedom of the passage which is opened to the air; and I have, therefore, always insisted on adopting all the means which are necessary to secure these conditions." In gauging the size of a tube, always look at the inner one as being the smaller, and remember that the smallest diameter at any point determines its capacity for breathing purposes. Tapering tubes are therefore to be avoided; for while they necessitate a large opening into the trachea, they do not afford more ample breathing space.

While speaking of the tube, I must not forget to mention the value of a moveable collar. The invention is due to LÜER, the well-known instrument maker of Paris; it is undoubtedly one of the most important modifications which the tracheotomy tube has ever undergone, and was made at the suggestion of M. ROGER, who was one of the first to recognise the dangers of an ill-fitting tube.†

\* 'Guy's Hospital Reports,' 1875, p. 495.

† 'Archives Générales,' 1859, vol. ii, p. 193.

The dotted lines (Fig. 7) show how the tracheal portion can alter its position during the various movements of the larynx and of the neck.

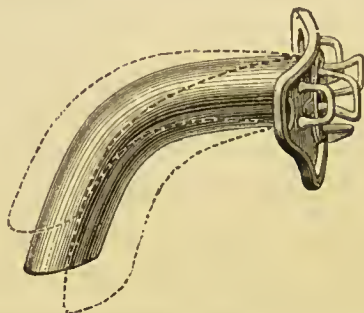


FIG. 7 shows the advantages of a Moveable Collar.

It is of first importance that the tube should fit comfortably. The tapes with which it is held in place ought not to be tied too tightly round the neck, but they must be tight enough to prevent displacement by the child's movements. With the moveable collar it is hardly possible to cause pressure against the posterior wall of the trachea; formerly this was a not infrequent source of pain when swallowing food, and sometimes of vomiting also. It will be remembered that the posterior wall of the trachea is membranous and adherent to the œsophagus. Cases are on record in which it has been perforated by an ill-fitting tube.

For rigid tubes, silver is by far the best material; aluminium, celluloid, and vulcanite tubes, though rather less costly, have many drawbacks. I will just add that great care should be exercised in their manufacture. The inner tube should glide easily within the outer one, so that, when in use, the trouble of removing it for cleaning, and of replacing it afterwards, is reduced to a minimum; the lower extremity should project about the  $\frac{1}{12}$ th of an inch beyond the outer tube, as in Fig. 4, p. 84. The interior of the inner tube may advantageously be polished; for this facilitates the removal of all impurities.



Mr. MORRANT BAKER, in 1876, introduced a flexible tube, but, unfortunately, of the old quarter-circle shape. He advocated its use in the belief that the danger of intra-tracheal erosions would be materially lessened. For my own part, I have never used these flexible tubes, since I regard the erosions as due to an ill-fitting or an ill-shaped tube, and not to the fact of its being made of silver. Indeed, specimens have since been shown at the Pathological Society bearing out my contention.

Theoretically, of course, a tube of any kind or shape is a mistake; all our ingenuity should be exercised to do without it. At present, however, I do not know of any adequate substitute. Mr. GOLDING-BIRD and Mr. G. A. BROWN have devised instruments to take the place of tubes, both more or less on the principle of the ordinary eye speculum. But I have not yet met with cases in which I could safely discard the older instrument.

I will venture to describe two other instruments in this place—the trachea dilator and the automatic retractor. All authors are agreed as to the importance of a dilator, and it is not therefore strange that a great variety has been invented. The annexed drawing shows the instru-

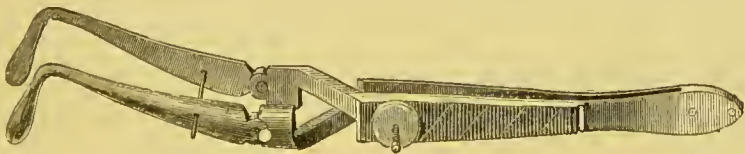


FIG. 8.—The Trachea Dilator.

ment which I prefer to any other. It is far preferable to the three-bladed instrument, which is recommended by some operators. The hinge in the blade permits of its being comfortably used in any position the patient may chance to be in, while the screw holds the blades open at any required width, and thus frees the operator's hand.

The "automatic retractor" is an instrument I devised after having been once or twice suddenly called upon to perform tracheotomy by the dissecting method, when there was no one near to assist me; and I need hardly say it is a very awkward operation to do alone. Under these circumstances, the "automatic retractor" (Fig. 9) will

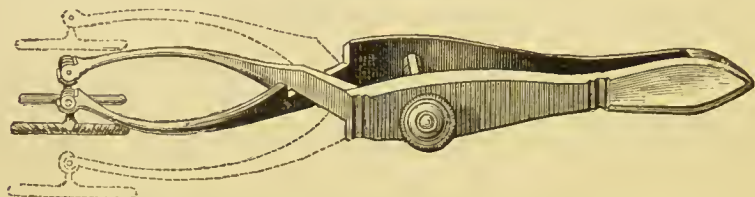


FIG. 9.—Author's Automatic Retractor.

be found useful. The incisions into the soft parts having been made, the blades of the retractor are introduced closed (like an eye speculum), and after being opened to the required extent the screw is adjusted. It does not take the place of a good assistant, but may occasionally prove serviceable when an assistant is not at hand.

THE OPERATION.—The various instruments required being laid out, the operating table should be placed so as to secure the best possible light. The child is then placed upon it, and if this have not been previously done chloroform is now administered. When the narcosis is completed, the patient must be got into position. The point to secure is the greatest possible prominence for the neck. This is best accomplished by laying the child on its back, and putting beneath the shoulders a small round cushion (one may extemporise a very useful cushion by rolling an empty wine-bottle in a towel). It matters little how it is accomplished, provided the end be attained. I may just add that I have myself failed, and have seen others fail also, to get the neck into a suitable position from using too large a cushion.

The trachea may be opened either above or below the isthmus of the thyroid gland. These operations are respectively called the high and the low operation.



FIG. 10 represents the arrangement of the Operating Table, &c.

The high operation is generally selected, because it is very much the easier in young children. It would, perhaps, be more rightly called a crico-tracheotomy, from the frequency with which the cricoid cartilage is incised, either accidentally or designedly. The low operation is more difficult, because of the greater relative depth of the trachea, the larger size and number of veins, and the vicinity of the great arterial trunks. The neck of a child is exceedingly short; it may almost be said not to have any neck at all. For these reasons the low operation should be discarded, unless some special reason exist to indicate it.

The child's head being well thrown back over the cushion, so as to make tense the tissues in front of the neck, and also to bring the laryngeal landmarks into greater prominence, and being held quite straight by an assistant, the operator, standing on the right of the table, with his left forefinger feels for the cricoid cartilage. A longitudinal mesial incision is then made, about one and a half or two inches long, commencing at the level of the cricoid cartilage or slightly above. The incision should be a bold one, so as to include the deeper fasciæ as well as the skin. I believe this facilitates the operation, for probably at no other stage of the proceeding can one better than now appreciate and keep to the median line, where, as I have shown, there are really no important structures to cut through, except perhaps the thyroid isthmus in exceptional cases.

The old operation.—Until within the last few years, in opening the trachea I have generally adopted the dissection method, advocated and practised by the late von LANGENBECK ; this method does away with the use of retractors, which, unless carefully handled, may drag the soft tissues and even the trachea out of the median line, and so add to, rather than lessen, the difficulties of the operation. On the other hand, an assistant becomes necessary, the essential feature of the LANGENBECK operation being the use of two pairs of dissecting forceps after the incision through the skin has once been made. One pair of forceps is held by the operator, who picks up any bit of tissue that needs dividing ; his assistant, with the second pair of forceps, lays hold exactly opposite, and together the tissue is raised up from the wound and divided by the operator. The proceeding is repeated until the trachea is laid bare, veins, as far as possible, being held aside. I would especially caution against making a funnel-



shaped dissection ; by this I mean making the deeper incisions gradually shorter and shorter (as compared with the external one) until the wound assumes the shape of a funnel.

Unless in skilled hands, retractors are dangerous aids ; for they may displace the trachea itself, and thus lead to its being incised laterally rather than in the median line. If retractors are used, retraction must be made uniformly on the two sides. The double instrument figured below



FIG. 11.—The Double Retractor.

is the best for the purpose. Retractors may also be used for keeping open the incised trachea in special cases where it is desirable to examine its interior or the larynx, when the usual dilator might be found a little in the way.

The isthmus of the thyroid gland may occasionally be found in the way ; it may be got rid of either,—first, by simply depressing it with a blunt hook or retractor ; second, by deliberately cutting through it ; third, by Dr. BOSE's\* method, which consists in making a transverse incision across the cricoid cartilage, so as to divide the layer of cervical fascia by which the isthmus is bound down. A director is then passed in, and the thyroid gland, together with its vessels, is easily separated from the trachea without hæmorrhage, and may then be depressed. The first method, in my hands, has generally sufficed. As for the second, I have adopted it in a few cases without any harm or inconvenience. Of course, if the isthmus be unusually large or vascular, depression in one or other of the ways described may be advantageously tried. I have

\* V. LANGENBECK'S 'Archiv für klinische Chirurgie,' vol. xiv, p. 144.

never tried BOSE's method on the living subject, simply because I have never had occasion to do so. The late Professor HÜTER considered the position and attachments of the isthmus a contra-indication to the high operation in young children. Certainly in cases where the isthmus is situated very high up it will be quite reasonable to raise up its lower border and incise the trachea below the isthmus if the surgeon thinks fit to do so ; for even then the trachea would be opened in its upper rings.

The cricoid cartilage and the two or three upper rings of the trachea having been exposed, the surgeon may now open the trachea. This should be done from below upwards. Some surgeons at this stage recommend that a sharp hook be used to fix the trachea. With M. MILLARD I believe that this is an unphysiological proceeding, for the trachea cannot be fixed without arresting respiration. Moreover, I see no surgical advantage which is gained by so doing. The space, especially in a young child, is never very extensive, and it may be requisite to cut the cricoid cartilage in order to secure sufficient room for the tube. Indeed, I am inclined to believe that it is advantageous rather than otherwise to cut the cricoid. The crico-thyroid membrane may also be nicked without danger. For it is very important that the opening be ample, or otherwise the tube will not fit in comfortably. I hope it will not appear superfluous to emphasize the advantage of a straight incision into the trachea. Besides increasing the difficulty of inserting the tube, a zigzag incision is thought to heal less kindly than a straight one, and to be a source of delay in finally removing the tube.

In a majority of cases there will be more or less hæmorrhage during the operation. Unless very profuse, it may be disregarded. If arterial, the artery may be

tied ; but if venous, it almost invariably stops as soon as respiration is freely re-established. Occasionally the hæmorrhage proceeds from some vessel which has just been nicked ; in this case the vessel may be tied in two places and cut across. If, owing to some abnormal arrangement of the vessels, an unusual or dangerous amount of hæmorrhage should occur, it must be treated *secundum artem*.

The newer operation.—For some four or five years past I have adopted a more expeditious method of opening the trachea. It consists in dividing the integument with an ordinary scalpel, and then cutting direct into the trachea without any dissection whatever. I claim for this method that it is simpler, as well as quicker, than the old dissecting operation. In all my later cases I have opened the trachea in this manner. It will be recognised as a modification of one proposed many years ago by CHASSAIGNAC, who, after fixing the larynx with a tenaculum, plunged the bistoury directly into the trachea. I tried this operation in one case, and must confess that it answered admirably ; but in withdrawing the knife, owing to the looseness of the skin in front of the neck, a rather jagged surface wound was produced. By previously cutting through this loose skin all difficulty is obviated.

I find, as the result of several operations, that everything can be attained by the method of operating which I have just described, namely, by two incisions. In order to be perfectly safe the incision must be in the median line. After the skin and fascia have been incised, the operator looks for the “white line,” the linear interval between the muscles of the two sides. It will be remembered that the muscles do not quite meet, and that, in point of fact, there is nothing between the trachea except the cervical fascia (the so-called “white line”) passing

across the muscles on the right to those on the left side. In short necks, and where there has been severe dyspnœa, some distended veins may be seen, but these can be avoided with a little care. Having found this white line, a suitable narrow-bladed scalpel is plunged into the trachea at the upper border of the thyroid isthmus, and made to cut its way out again just below the cricoid cartilage; or this latter may be divided, if necessary, to make more room for a good-sized tube. A pair of dilating forceps is then passed in, and the opening kept patent. Should any vessel spurt, a pair of pressure forceps can be clipped on. It is the operation *par excellence* when a surgeon is single-handed.

Formerly, I regarded the operation of tracheotomy as of little moment in cases of diphtheria; but longer experience of such cases teaches me that the mere fact of incising the tissues of the neck adds a material danger to the original disease. Considered from the most modern standpoint, the local disease is due to the necrobiotic action of certain micro-organisms on the cells of the affected parts. This being so, it is easy to conceive that an operation, in such a region too, should be a source of danger, and especially so when done by the dissecting method. The tissues are incised, blood- and lymph-vessels are cut across, and intermuscular planes and the soft cellular tissue around the trachea are disturbed and exposed. Thus so many fresh channels, through which septic materials may be absorbed, are opened up to the infective surroundings, and to the discharges which begin to issue from the trachea as soon as the operation is completed; and it is well known how readily freshly incised wounds become infected when exposed to septic influences. In this connection it will be remembered that the late Professor TROUSSEAU used to teach that a tracheotomy wound should be well painted



with nitrate of silver from the very first, in order to lessen the chances of septic infection. The obvious surgical indication, therefore, is to try and secure a free opening into the trachea with the least possible disturbance of the surrounding parts. The more virulent the case, the greater the need of this care. Hence the newer operation.

Having arrived at this stage all immediate danger of suffocation will have passed. There will be no further need of chloroform, and the child may be allowed gradually to wake up. The trachea being now held open by the dilator, the surgeon proceeds to what is the most important part of the operation, viz. the clearing away of the exudation which has been the cause of the laryngeal obstruction. This is accomplished very effectually by means of a feather. It must be previously soaked in a warm solution of carbonate of soda, then it is passed into the trachea, and gently but thoroughly twirled about so as to loosen as well as entangle the membrane. This manœuvre gives rise to a little cough, by which the loosened membrane is expelled. Next, the feather must be passed upwards into the larynx, through the glottis, and into the mouth, where it will be seen frequently with shreds of membrane hanging to it.

Clearing out the trachea.—It is most important that all membrane be thoroughly got rid of; for membrane is dangerous, not only because it offers a mechanical hindrance to respiration, but also because it is infectious to adjoining and contiguous structures. A further reason why the parts should be carefully freed from all foreign matter is, its presence here is a source of irritation, which distresses the patient. Under ordinary circumstances, we

can voluntarily clear the glottis of any irritating matter by coughing—a reflex process set up for the purpose. But after tracheotomy this is impossible, for the air is diverted through the tracheal wound. If it be found that the membrane is very tough or very adherent, or if it have already extended downwards below the point of the incision, it will be well to spray into the trachea some of the solution of carbonate of soda. This must be repeated several times if necessary. It ought to give rise to some coughing; after an interval of a few minutes the feather may again be used.

Suction.—A still more effectual mode of dealing with retained secretions, membrane or otherwise, is suction. But this should not be done directly by the mouth; in malignant cases and during epidemics, and also on account of special individual receptivity, the proceeding is not entirely without danger to the operator. I have therefore devised a little apparatus—the ‘trachea aspirator’—represented below.

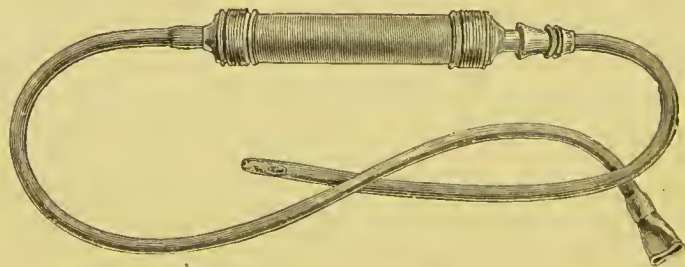


FIG. 12.—Author's Trachea Aspirator.

It consists of a small glass or celluloid cylinder, three or four inches long by three quarters of an inch in diameter, to one extremity of which a flexible hollow tube (a silk catheter) is fixed, and to the other an india-rubber tube having an appropriate mouthpiece. The various parts unscrew to facilitate cleaning after use. When it is going to be used the cylinder is loosely packed with

some antiseptic or sterilised wool, which effectually acts as a filter and prevents the *materies morbi* from entering the operator's mouth. It must be carefully cleansed after use each time. The advantage of using the mouth is obvious ; the operator can more readily and more delicately adjust the amount of force to be used ; he *feels* what he is doing, and is more expeditious and more certain in his results. In default of this, an ordinary silk elastic catheter, or even a piece of bent glass tubing, may be substituted ; the mouthpiece should be covered with two or three thicknesses of fine linen rag. If the tracheal wound is large, it must be closed in some way or other, in order to secure the vacuum necessary to make aspiration effectual.

The plan of putting the lips directly to the tracheal wound for the purpose of sucking out membrane is not to be recommended on any grounds, but chiefly because it cannot possibly be of any service to the patient, and may prove very disastrous to the operator. Moreover, it is based on a false conception of the nature of the difficulty to be overcome. Those who are most conversant with the appearances of the trachea will be the least likely to adopt the plan ; the obstruction requiring aspiration is rarely in the trachea (where membrane when present is generally very loosely attached), but at the bifurcation of one or other bronchus. Even if the obstruction be due to blood which has found its way into the trachea during the operation, suction with the lips can be of little avail, for the blood gets down towards the bifurcation, where it coagulates, and becomes difficult to remove. The trachea aspirator, just described, will be found much more useful and more powerful than the lips. The catheter end is passed into the trachea, directed towards the bronchus which appears to be oc-

cluded, and suction is then made, so to speak, on the spot. This spot is far out of the reach of any suction power that can be exerted by the lips, applied directly to the opening in the trachea.

The larynx and trachea having been well cleared out, the tube may now be inserted and secured with tapes. The introduction of the tube into the trachea is not always an easy matter. It may be that the trachea is not quite exposed, or that the incision is too small, or not quite in the median line, or that hæmorrhage obscures the opening. In all cases the surgeon must act deliberately. If the opening, such as it is, is kept patent with the dilator no harm can come to the patient. Its exact size, shape, and position must be made out. If found too small (a very common fault) it must be carefully enlarged with the tip of the scalpel: if situated very much on one side, I believe it is better to make a fresh median opening and leave the other to close. I should especially warn against the use of the so-called bivalve tube under these circumstances. It can doubtless be very easily introduced even through a small opening; but this at best is a sorry way to overcome a difficulty dependent on an imperfect and insufficient incision into the trachea.

It is very advantageous to examine with some care the interior of the larynx and trachea at this stage. By throwing up a light with a laryngeal mirror, it is usually quite easy to see the vocal cords; the absence or presence of membrane can also be determined, and occasionally in an obscure case a doubt as to diagnosis may be cleared up in this manner.



## POSSIBLE ACCIDENTS.

This chapter would hardly be complete without mention of some of the dangers which may occur during, as well as immediately after, the operation.

Apparent death.—From one of many causes or from a combination of circumstances—either because permission could not be obtained to operate earlier, or because the surgeon was not at hand, or in consequence of a sudden accession of dyspnœa, or in consequence of unforeseen accidents and delay during the operation—the patient may cease to breathe and to all appearances may seem dead, before the operation can be completed. What should the surgeon do under these circumstances? I strongly advise that the trachea be opened and cleared out, and then, that systematic, steady, and prolonged efforts of artificial respiration be made to restore the patient. I have several times seen cases apparently brought to life again, even after an interval of many minutes. It is important to bear in mind that our efforts are not likely to succeed unless the interior of the trachea be free from obstruction.

Blood in the trachea.—Occasionally, blood in considerable quantity may find its way into the trachea. It may be in consequence of wounding some unusually placed vessel, or from having incised the trachea before it has been fully exposed. Sometimes, in very urgent cases, the surgeon loses a little of his calm, and makes his tracheal incision on one side, and after having withdrawn his scalpel he is unable to get in either the tube or the dilator. Thus considerable quantities of blood may be drawn into the lungs, and by coagulating may add to the

immediate danger and distress of the patient, while, subsequently, its decomposition may be the starting-point of a fatal septic pneumonia. In such cases, aspiration is clearly the remedy, and the little instrument just described may advantageously be employed.

Surgical emphysema.—An untoward result, which sometimes occurs, is surgical emphysema. I have seen the entire neck, and even the face, swell up to double their usual size. It is usually ascribed to the escape of air through a non-median incision into a part of the trachea which is not thoroughly exposed. Now, although I have many times seen the trachea incised in more places than one, I have only once or twice seen emphysema. I am therefore inclined to think that the air must get into the cellular tissue in some other way. No explanation seems so reasonable as that offered by Dr. CHAMPNEYS, that it is sucked in by the inspiratory efforts of the patient; it is likely to occur therefore in cases where the dyspnœa is most urgent, or in unduly prolonged operations during which the patient is generally held in a very constrained position. The remedy is obvious. I believe it is well to disregard all previous incisions, and to make a fresh one in the median line, quite irrespective of them; for as soon as a free opening is once established, no further ill consequences happen, and the smaller openings close spontaneously.

The operation fails to relieve.—Even after a well-performed operation, and notwithstanding a careful incision of the trachea, it sometimes happens that the insertion of the tube is not followed by that relief which we always so anxiously look for. The secret is often to be found in the fact that the trachea has not been sufficiently cleared out, or that the tube has actually been inserted between the tracheal wall and a complete mem-

branous cast which it has but partially thrust aside. Indeed, I have an anatomical specimen illustrating how this may occur. The surgeon often feels that his patient is not safe until the tube is inserted, and he hurries to accomplish this. But let it be remembered that, with a dilator in use, immediate danger need not be apprehended; while, on the other hand, a tube inserted too soon may prove but a false security.

Occlusion of a bronchus.—I must also just refer to the possibility of one or other bronchus being more or less occluded by shreds of membrane loosened by the feather, or by clots of coagulated blood which may have been drawn in during the operation. Such a condition may be suspected when air does not enter the chest freely, and where the physical signs do not point to consolidation or disease of the lung itself, or in cases where one side of the chest fills more perfectly than the other. In such cases the trachea aspirator should be introduced, and an attempt made to remove the obstruction. I have never had occasion to regret carrying this treatment out freely, but I have occasionally blamed myself—when too late—for not having sufficiently acted up to my precepts.

As regards this treatment of the interior of the trachea, I can express my own conviction, based on many years' experience, that it may be undertaken without any hesitation; and provided it be done gently and with the "tactus eruditus" of a surgeon, without the slightest damage to the trachea. I believe such treatment is infinitely less irritating and less dangerous to the trachea than the sojourn of membranous exudation within or upon it.

The presence of membrane in the larynx or trachea after death, in a case of laryngitis for which tracheotomy

has been performed, is a condition which few surgeons, I think, will care to contemplate; since the main object of the operation of tracheotomy has been to remove this membrane.



## CHAPTER V.

### DETAILS OF AFTER-TREATMENT.

*No hard and fast line of after-treatment—The sick room—Nursing—Indications for after-treatment—Steam—Croup bed—Croup steam apparatus—Disinfectants—Sedatives—Solvents—Suction of trachea—Management of tube—Diet.*

I NEED hardly say that there is no hard and fast line of “after-treatment;” or that this will depend on the primary lesion which has necessitated the operation, rather than upon any peculiar condition which the operation itself introduces. The after-treatment of a tracheotomy undertaken, for instance, for the removal of a foreign body recently lodged in the windpipe, is of the simplest kind; a pad of antiseptised lint and a bandage are all that is usually necessary. Complications are very uncommon, and the wound is generally healed in two or three days. On the other hand, when the operation is undertaken to relieve a symptom or a consequence of disease, we still have to grapple with that disease, which, if unrelieved, may itself prove fatal. What follows in this chapter chiefly concerns the after-treatment of tracheotomy in laryngeal diphtheria.

THE SICK ROOM.—The room for a patient after tracheotomy should be large and airy, and by choice, have a

south aspect. All unnecessary furniture should be removed as well as the carpet and curtains. A fireplace is almost essential. The doorway should be guarded by a large sheet, kept constantly wetted with carbolic solution. The room should be near a w.c. in order that discharges of all kinds after being carefully disinfected may be easily got rid of, without having to be carried through the house.

NURSING.—A well-trained nurse to take charge of the patient is most essential. Although a few cases recover without having a nurse, yet a large number die, chiefly in consequence of insufficient nursing. Neither good intentions nor devotion suffice. The nurse in charge of a tracheotomy needs the special knowledge which special training and experience alone can give. For she has to deal with an insidious disease, affecting the most vital function of the body. An unrecognised plug of membrane in the tube may suffocate the patient in a few seconds, before other help can be summoned, although the danger could be removed with a feather. The tube may get displaced by accident; even if she could not replace it a trained nurse would know how to use the dilator until the surgeon could be sent for, and thus save her patient.

But there are many other duties, hardly less important, which can only be trusted to a good nurse. Cleaning the tube, the regulation of the steam apparatus, the administration of medicines, and last, but not least, the administration of nourishment. On all these points the nurse must be full of resource, apt, and ready to do the right thing at the right moment. She must anticipate her patient's wishes, and instinctively feel the little troubles and sufferings which he can no longer give

utterance to. Above all, her supervision must be constant and untiring; in the absence of the surgeon, she must have complete control over the patient.

[A nurse requires rest and fresh air, especially while in charge of diphtheria patients. A stated amount of sleep, and of exercise in the open air, are as essential to her health as health is essential to the proper discharge of her duties.]

CHIEF INDICATION AS TO AFTER-TREATMENT.—As the chief object of the operation in a case of diphtheria has been the removal of a mechanical hindrance to the admission of air into the lungs, so the chief indication in the after-treatment is the prevention of any subsequent recurrence of this obstruction.

It is almost needless to say that the false membranes in these cases have a marked tendency to re-form, often more than once, after removal; and hence it behoves the surgeon to be constantly on the look-out for the earliest symptoms which betoken such recurrence. Among the most suggestive must be reckoned a want of tracheal secretion from the wound—a “dry tracheotomy,” as the phrase goes in the wards. Immediately after the operation, after all membrane has been feathered away, there will generally be some secretion; and if in the course of a few hours this secretion ceases, and if the breathing through the tube is dry and whistling, a fresh deposit of membrane may be suspected; the trachea ought to be carefully examined, and whether membrane be seen or not, it will be advantageous to feather it out again with a little soda solution or glycerine and water. This proceeding may be repeated several times at short intervals if necessary. I have already expressed my opinion that membrane is dangerous, not only because it mechanically

interferes with the admission of air into the lungs, but also because it is infective. Its continued formation is, moreover, the visible proof of an infective process still active in the body; and there is an ever-increasing danger of what at first is a purely local disease passing down into the lungs and so beyond reach. I again refer to this point because it ought ever to be present to the surgeon's mind, and should constantly influence his plan of treatment.

The value and importance of frequently examining the condition of the wound and the trachea with the assistance of a reflector, after the tube has been removed, cannot be over-estimated. Nothing can be worse than to "rest and be thankful." The tube should be removed twice daily until the surgeon is assured that the membrane is not being re-formed on the one hand, and that it is not spreading on the other. Let it be remembered that once past the limits of the trachea it has passed beyond the reach of the surgeon.

VALUE AND MODE OF APPLICATION OF STEAM.—Various means may be used to facilitate the removal of membrane. I have already referred to the use of a feather at the time of the operation and subsequently. Perhaps the most important aid, however, is the inhalation of steam. For this purpose the patient's bed should be surrounded with curtains. The plan I found in use at the Hospital for Sick Children many years ago, when Resident Medical Officer, seems to me the most suitable. A rod (of wood or iron) is strapped to each one of the four legs of an ordinary cot; these four uprights are then connected together by four cross rods, as in Fig. 13. In this manner the cot is converted into a four-post bed. Ordinary white sheets are then thrown over this extemporised framework,



so as to cover in the cot on all sides but one. The advantages of this kind of bed, whether it is used in private houses or in hospital wards, are obvious. In the first place, it isolates the patient, and gives greater control over his surroundings than could otherwise be had ; we can regulate the temperature of the air and the amount of steam ; and, further, we can make the steam the vehicle for various kinds of medication—antiseptics, anodynes, stimulants, or expectorants, according to the requirements of the case—and this, too, without in any way interfering with the comfort of the other occupants of the room.

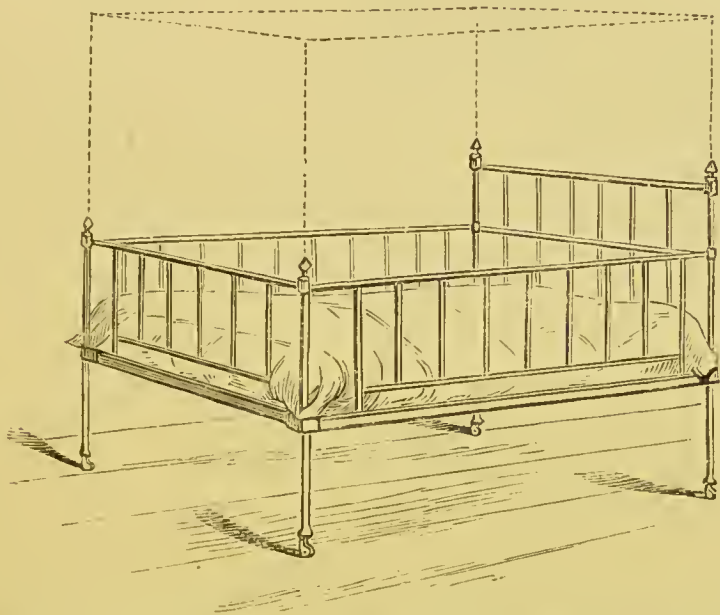


FIG. 13.—An ordinary Cot. The dotted lines represent the moveable framework.

A small steam apparatus is kept boiling on a table close by, from which a certain amount of steam must be conducted into the bed, as in Fig. 14. The framework can be extemporised out of wooden laths, or in any other way ; but for the sake of convenience, I have

designed a light, portable, expanding iron frame, which will adapt itself to any bed, and which the surgeon can carry with him as part of his ARMAMENTARIUM.

Even when the case is in a separate room, it is a great advantage to have such a means of isolating the patient ; for, thanks to the protection of the curtains and the warmth supplied by the steam apparatus, the door and

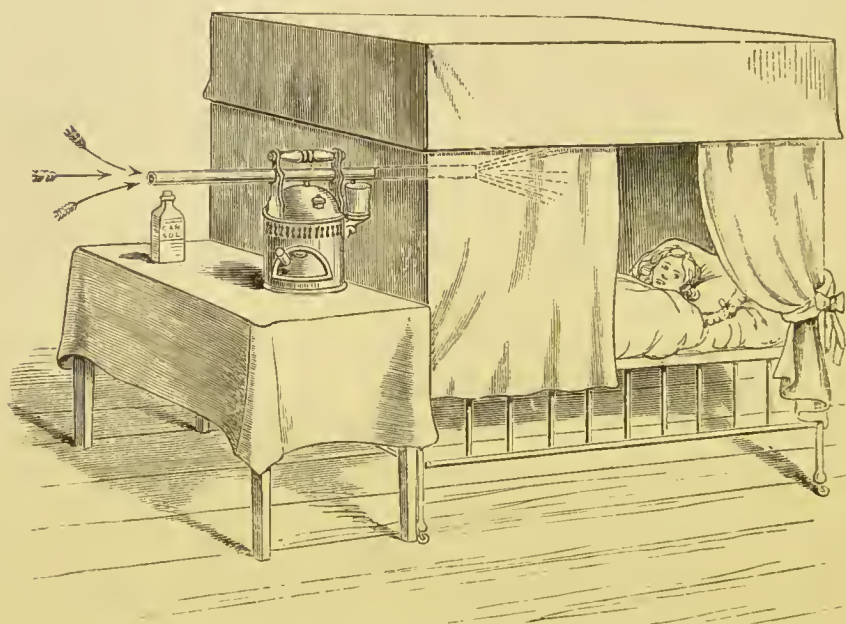


FIG. 14.—The Croup Bed complete, with the steam apparatus. The arrows indicate the current of air, which is being insensibly introduced along with the steam.\*

window of the room can be opened without any fear of draughts, and a free ventilation kept up. This is of importance both to the patient and the nurse.

The plan (still in use at some hospitals) of drawing the bed close up to the fireplace, surrounding it with the ordinary ward screens, and then covering them in with blankets, does not seem to me as good as the one I have just recom-

\* They can be obtained of Messrs. ALLEN, Marylebone Lane, London.

mended. For it is more difficult to regulate the temperature, and it frequently deprives the patient both of the fresh air and light, which are so necessary for recovery.

In order, however, to secure the full benefit of steam, and especially when using the "Croup Bed" just described, it must be applied scientifically. For this purpose, the Ventilating steam apparatus is the most use-

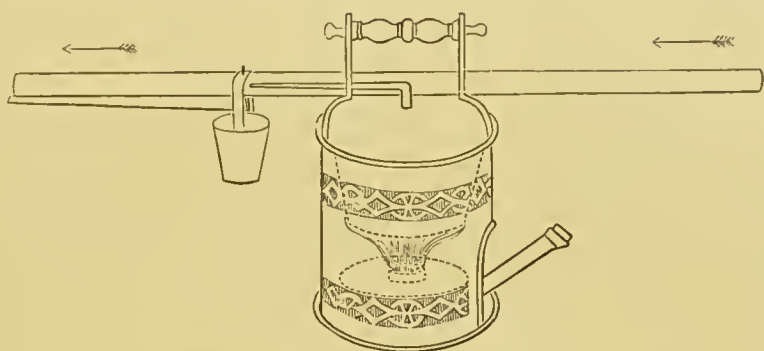


FIG. 15.—The Ventilating Steamer for Croup cases.

ful. It was made in this present form at my suggestion, by Messrs. ALLEN, and utilises the well-known principle of the "steam draught," first applied in this connection by Dr. LEE, at the suggestion of the late Mr. NAPIER.\*

The construction of this apparatus is shown in the drawing; the principle on which it works is very simple. Owing to the velocity with which the steam issues from the boiler, the air in the tube is driven out at one extremity, while fresh air rushes in at the other to replace it. In the course of a short time the tube and the air passing through it become warmed. A constant current of fresh, warmed, moist air is thus supplied into the croup bed.

[The following general instructions as regards the steamer will be found useful. See that the steam nozzle

\* *Vide* 'Medical Times and Gazette,' February 3rd, 1883, p. 143.

is patent, or otherwise an accident may occur. The boiler should never be more than half filled. Boiling water should be used for the purpose. The amount of flame should vary with the amount of steam required. Be careful that the kettle does not boil dry.

If any medicaments, all of which must be volatilisable, are used, they must be mixed with a little warm water in a measure, and then poured into the kettle with the hot water. Always remove the lamp and let the steam go down before opening the boiler.

If any resinous substances have been used (such as benzoin), let the kettle be carefully washed with strong soda and water before it is put away; the steam nozzle also should be screwed off and carefully cleaned. When not in use, the kettle should be kept empty and dry.]

The amount of steam required varies with the individual case. Its indication may, I think, be formulated thus:—The less there is of tracheal secretion, the more is steam needed; and the converse. An excess, however, is in all cases to be avoided, as it tends to depress the patient. Steam acts on the bronchial mucous membrane much as it acts on the skin; it encourages secretion; the secretion tends to loosen the membranous exudation, and so bring it within the current of the expired air, by which it is expelled. It may be made the vehicle of important medication, of which not the least useful is disinfection.

The importance of systematically using disinfectants cannot be over-estimated. There is abundant evidence to show that diphtheria not infrequently arises from exposure to drain emanations. This, I think, is not to be wondered at, if the exudations of patients suffering from diphtheria are thrown away without being thoroughly



sterilised, just as is now done with the stools of typhoid patients. So, too, with the air they breathe. By adding a little carbolic acid or creasote to the water in the croup kettle, a disinfecting atmosphere can be supplied to them, which will tend very much to lessen the chances of a spread of the disease.

Creasote, besides being disinfectant, has a stimulating influence on the bronchial mucous membrane, and promotes secretion. The *Oleum Pini Sylvestris* belongs to the same class, and is an aromatic expectorant possessing antiseptic properties. Eucalyptus oil and thymol are both agreeable and efficient. Many other substances may be used; such only, however, as are volatile should be tried.

Under certain circumstances, it may be well, while keeping up a gentle disinfecting vapour, to apply from time to time sedatives. There is often a troublesome cough, which distresses the patient. In such cases some small inhaler will be found of great service, for more highly medicated steam can be applied directly to the trachea than is possible with the croup kettle. Thus the compound Tincture of Benzoin (3j to 5j of water) when inhaled is an excellent sedative. It may be combined with a few drops of chloroform, or given alone, according to the requirements. When an inhaler is not within reach, a good substitute is a large soft sponge wrung out of boiling water, on to which the benzoin or other medication is dropped; the sponge is held in front of the tube for a few minutes at a time.

THE VALUE OF SOLVENTS.—Next in importance to steam come solvents,—drugs, the action of which is to liquefy mucous and membranous exudations. Soda and potash are the most valuable of this class. After many experimental trials, I am inclined to regard the soda

solution as the most generally useful. (Sodii Carbon.  $\text{ʒiiss}$  —  $\text{ʒiiss}$ , Glycerini  $\text{ʒij}$ , Aq. Destill. ad  $\text{ʒviiij}$ .) It may be sprayed in front of the cannula, in such a way that the spray is inhaled; this may be continued for five minutes at a time, and repeated at longer or shorter intervals through the day as circumstances dictate.

A convenient arrangement for spraying a child is shown in Fig. 16. The child is seated on the nurse's knee, and



FIG. 16.—Mode of using the Spray.

is then covered with a waterproof in order to protect its dress from wet and damp. A steam spray should be used if possible; for the fluid to be sprayed is thus more minutely divided, and it penetrates more easily into the air-passages. Otherwise a hand spray may be used.

Shortly after each spraying let the feather be introduced so as to detach and get rid of any shreds of loosened mem-

brane. The soda solution is useful, I believe, not only because it liquefies any membrane with which it comes in contact, but also because it renders the exudation material less organisable.

SUCTION.—There is another means by which false membranes, inspissated mucus, blood, &c., may be got up from the trachea and primary bronchi, should neither steam, nor the use of feathers, nor the solvents suffice. It may be sucked out. I have already referred to this method in describing the operation (p. 98), but think that a further reference is not out of place, seeing how useful it may prove to the patient. Obstructed breathing may frequently be relieved by this means, and success obtained where, without it, death would be inevitable.

But suction should never be made directly with the mouth from the tracheal tube or from the wound, as I have already pointed out ; it can only be of service in cases where there is mechanical obstruction, and in order to obtain its fullest efficiency the instrument used should be in direct contact with the material to be got rid of. Thus it is important to use the feather and endeavour to detach the membrane ; but should this not succeed, or should membrane or inspissated mucus get wedged in a bronchus, then suction with the aspirator carefully applied may prove of great benefit. If the trachea aspirator is used, the tube should be directed towards that bronchus which appears obstructed, and after closing the wound with the finger and thumb over the tube, gentle and sudden suction with the mouth should be made. As a further precaution the mouth may be subsequently washed out with carbolic solution.

From within a short time of the operation there will

probably have been some secretion from the tracheal wound ; and if there is much cough, the mucus, together with the air, will give rise to a "rattling" sound, which at first causes anxiety to the attendant. This, however, is not an unfavorable sign. Whenever much mucus is being expectorated it should be cleaned off the tube with a sponge, and the tube itself must now and then be cleaned out with a feather. Be careful, however, not to worry the patient with too much attention.

Speaking generally, I would say that a free secretion from the trachea is not an unfavorable sign. Indeed, it will be seen that one object of the treatment just proposed has been to encourage secretion in the first place, and to secure its removal in the second. On the other hand, a dry tracheotomy is generally to be regarded with anxiety. The dry cases are usually exceedingly tolerant of interference, allowing a feather to be inserted into the trachea without any reflex cough. This, too, is a very unfavorable sign, and should always induce a most guarded prognosis. Our efforts to promote secretion should be redoubled, the child's general condition carefully examined, and any special indication met by a corresponding effort to overcome it.

An efficacious means for increasing tracheal and bronchial secretion is the hypodermic injection of pilocarpine. It lowers temperature also, and begins to act in about five or ten minutes after its administration. But it has the drawback of being rather depressing, and cannot therefore always be recommended. Nevertheless when other measures have failed, and the circumstances are urgent, it is a drug to fall back upon, on the principle that "*un remède expérimenté vaut mieux qu'un désespoir assuré.*"

The solution I use is as follows :—Nitrate of pilocarpine,



1 grain. Distilled water, 20 minims. Mix. Dose: 2 to 6 minims, hypodermically. A little brandy or brandy mixture may be ordered at the same time.

CHANGING AND CLEANING THE TUBE.—We next come to consider the question of changing and cleaning the tracheal tube. How often does it require cleaning? is the first point one naturally thinks of. The inner tube must be taken out every hour or two, and cleaned with a feather and warm water; if the mucus is very tenacious, the soda solution will be found useful, and may be used instead of plain water for washing it, after its removal. If the patient's temperature is very high, the tube will require more frequent cleaning; for the metal tube gets heated by the body, and the secretions are more apt to inspissate in consequence. The exterior tube also ought to be cleaned after the lapse of not more than twenty-four hours. This is a useful proceeding for many reasons, as already stated on page 108; it allows us to detect the earliest signs of unhealthiness in the external wound, as well as to apply the appropriate remedies. Sometimes the tube after its removal from the trachea will be found blackened. If such is the case let the wound be carefully examined. Each of the black patches (due to the sulphuretted hydrogen of decomposing discharges) will be found to correspond with some unhealthy or sloughing spot in the trachea, which must be treated accordingly. Indeed, I regard this blackening of the silver tube as an important aid in diagnosing the condition of the interior of the trachea; it is often the earliest manifestation of some morbid departure, which if not checked at once may prove of great danger to the patient.

There is not much difficulty, as a rule, in re-introducing the tube; but it is always well to have a dilator at hand,

in case difficulties should present themselves. I generally keep a second tube ready, identical in all respects except length, with which to replace the one removed; and so alternate from day to day as circumstances suggest. This is an effectual method of preventing the erosions of the tracheal wall, to which reference will be made under 'Complications.' Another advantage of taking out the exterior tube is that it affords an opportunity for testing the breathing power through the larynx after two or three days.

The re-introduction of the tube, as I have just said, is not as a rule difficult, for the incised tissues in front of the trachea all become glued together with inflammatory lymph; and a tunnel leading directly into the trachea is quickly formed. It is in itself a good sign, when this adhesion takes place, for while it facilitates access to the trachea, it prevents bagging of secretions among the intermuscular planes, to which reference will again be made under the heading of 'Complications.' In some cases, however, no such adhesion takes place, or it takes place but slowly, and then the re-introduction of the tube is proportionately more difficult. In these cases it will be necessary to have the dilator at hand, and proceed as deliberately and much in the same way as at the operation. I do not think that this asthenic condition of the wound should interfere with the proper changing of the tube; indeed, its condition can never be rightly gauged until the first dressing has been carried out; and with the possibility of finding the way into the trachea not yet well defined, it is always wise to do this first changing of the tube with the child on the operating table, and one's instruments all ready to hand. In a few cases the edges of the wound may be found in a very unhealthy condition, or deposits of membrane may be seen; we must treat

them on general principles, not forgetting what has been said on the importance of destroying all local manifestations, whenever and wherever met with.

The condition of the tracheal wound varies very much ; in unhealthy and weakly children the tissues in front of the trachea become oedematous, sloughy, and exude a thin unwholesome discharge. In such cases it is advantageous to remove the tube, and leave it out as long as possible, either spraying the wound surface with some astringent lotion, or dusting it over with iodoform or boric acid. If the opening into the trachea shows signs of closing, the tube must be inserted again. In one such case I passed a thread of silk through the edges of the trachea, and tied them round the neck. This keeps open the wound efficiently for a short time, but the silk tends to cut its way out if left beyond a few hours.

PERMANENT REMOVAL OF TUBE.—Finally, we have to consider the permanent removal of the tube. If it is regularly taken out, as recommended, for cleaning purposes, we shall be able to test the condition of the glottis from time to time ; and it is well to do so, and to commence our trials about the third day. It will be evident that we cannot make satisfactory trials so long as the tube is in the trachea, even although the tube may have a window in its posterior wall. Some surgeons simply place the finger tip over the orifice of the tube. I much prefer to remove it, and then completely close the opening into the trachea with a pad of wetted lint, lightly tied round the neck with a soft bandage.

The first few breaths are often very laboured. As a rule, it is chiefly during inspiration that difficulty is experienced ; but occasionally expiration is also difficult. The surgeon must persevere as long as it is safe to do so,

and renew his attempts at short intervals. A very easy way of testing the patency of the larynx is to allow the patient to fill his chest through the tracheal wound, and then to force him, if possible, to expire it through the larynx. If this can be accomplished, it will be an indication that there is no mechanical impediment in the larynx ; if it cannot, it will be an indication to ascertain its nature and if possible remove its cause. It is a good plan also, even before the tubes can be finally removed, to make the child attempt to phonate ; for this exercises the muscles, and overcomes the rigidity arising from inflammatory thickening. It will be found useful to spray the pharynx with strong alum solution, especially when the child is trying to use the larynx, for the spray will be drawn in along with the air, and so reach the glottis. In a few cases, as suggested by Dr. WILKS, the difficulty of breathing may be due to paralysis of the vocal cords : "The inspired current of air draws the paralysed cords inwards until they meet and close the glottis."

Usually there are no great difficulties ; such as there are will be considered under 'Complications.' The tube having been removed the wound may be allowed to close. A pad of wet boracic lint, fastened over the wound with a turn of bandage, is usually all that is required. If granulations spring up, they may be lightly touched with nitrate of silver stick.

Dr. SANNÉ, in his excellent Thesis, states that from the fifth to the ninth day after operation is the period during which the tube can most frequently be removed permanently ; in my own experience the average time lies somewhere between the eighth and eleventh days.

DIET.—The late Professor TROUSSEAU used to teach that a good appetite was one of the most hopeful signs in a



child that had been tracheotomised. Unfortunately it is rather uncommon, and not a little after-trouble consists in persuading our patients to take nourishment. On this account, we must be on our guard against overdoing it. I have known otherwise excellent nurses ply their patients every half-hour or oftener, for days together, with either milk or beef tea, or some other article of diet that may have been ordered. This practice I consider as injudicious as it is injurious. It is impossible for the stomach to be digesting food continuously ; and unless the food is digested it only distends the stomach and gives rise to general malaise and discomfort. In children or even adults, where the depression is great, this digestive inactivity specially obtains ; hence at *post-mortem* examinations it is very common to find the stomach greatly distended with undigested food. It is not difficult to surmise that the heart's action, as well as expansion of the lung, must have been materially interfered with. In other cases this ill-advised feeding leads to vomiting, and to a not unnatural repugnance to food.

It is, I know, easier to advise what ought not to be done than to give any definite instructions as to what should be done. The moral of what precedes is that a little food which is digested is of greater value than a large quantity which is merely swallowed.

By some it is considered necessary to order beef tea and milk quite irrespective of the likes or dislikes of the patient. Children, as a rule, dislike beef tea. Under these circumstances I should not advise its being pressed. The same as regards milk. More solid food may be given, if it be wished for, without any danger. Indeed, soft solids are often more easily swallowed than liquids. The latter seem to find their way into the larynx, and then they give rise to coughing. Beef tea or

milk may now and again be advantageously thickened with biscuit powder, sago, tapioca, the yolk of an egg, or with chocolate; the addition of a little cream is also useful. Beef tea may also be given cold in the form of jelly; it should be variously flavoured in order not to pall on the appetite; great care should be exercised in making it really palatable. Light puddings are sometimes relished, served with a little fruit juice. Raw or undercooked lean meat, chopped very fine, or pounded, is another excellent way of administering food.

A little home-made calves'-foot or chicken jelly is an excellent and nourishing food. They may be given in a semi-liquid form. At all stages of the disease fresh fruit, or the juice if it can be had, will be found useful: apart from its febrifuge qualities, fruit is refreshing and appetising. Baked apples or pears, freed from skin and husks, may be given in moderation. A little bit of orange, or of lemon covered with fine sugar, may be sucked from time to time. But I have already entered into the question of food and feeding in an earlier part of my book, and I would refer the reader back to what has there been said.

If other measures fail, forced feeding, as recommended by TROUSSEAU, must be resorted to. A soft silk, or india-rubber, catheter (No. 7 size) is better than the ordinary rigid œsophageal tube. This must be passed through the nose into the stomach; to the free extremity either the nozzle of a glass syringe, or the stem of a small glass funnel is fitted, and a measured quantity of suitable food is slowly poured in. Mr. BATTAMS, Resident Medical Officer at the East London Children's Hospital, who has had a unique experience in this matter, has devised a very useful and simple syringe-feeder for this purpose, which I can confidently recommend. It is

figured below. Children become reconciled to this mode of feeding very quickly when it is carried out gently.



FIG. 17.—A simple instrument for forced feeding.

A little good wine, brandy, or brandy mixture (B. P.) will sometimes sustain life, and put the patient over a period of depression and exhaustion, which would be fatal without it. This is especially the case where the vomiting is severe, and accompanied with diarrhœa. Nutritive enemata, thickened with raw starch and containing a small opiate, may be administered every few hours. Vomiting and diarrhœa in a few cases recur and persist; they are very exhausting. I believe they sometimes depend on the action of drugs given before the operation, in which case, of course, they tend gradually to wear off.

I will close this chapter with another caution against too frequent feeding. Every two hours is often enough when the food has to be forced; and then a measured quantity should be given. If the patient ask for it oftener, well and good. The return of the appetite is a most hopeful sign, and generally a harbinger of success.

## CHAPTER VI.

### COMPLICATIONS FOLLOWING TRACHEOTOMY. ILLUSTRATIVE CASES.

*Complications divided into immediate and remote—Cases illustrating these conditions, with remarks—Difficulties in removing the tube—Mental agitation—Miscellaneous cases—Sudden deaths—Undetected foreign bodies.*

THE term 'complications' is here used in a rather wide sense, and may be defined as any conditions which retard or prevent the restitution of the laryngeal function and the permanent removal of the cannula. I shall refer only to such complications as are concerned directly with the operation. Septic (broncho-) pneumonia will not therefore be included. I cannot agree with those who attribute the pneumonia to the tracheotomy, as it seldom ensues on this operation when undertaken for conditions other than diphtheria; whereas pneumonia is constantly found *post mortem* in cases of diphtheria which have not been tracheotomised.

Contrary to the view expressed in the first edition of this work, as the outcome of greater experience I now hold that the operation of tracheotomy in diphtheria does introduce an additional element of danger. The freshly incised tissues, with their innumerable arterioles, venules, and lymphatics, are so many additional channels into which the virus may directly penetrate; and that it does



penetrate is clearly shown by the frequency of inflammatory complications, such as are rarely, if ever, seen when the operation is done for the removal of a foreign body or for chronic disease. Some of the cases I am about to relate do not strictly belong to a work on laryngeal diphtheria ; but in all cases of obstruction in young children it is desirable to eliminate diphtheria as a possible complication, even although the obstruction may be said to be of a chronic nature. As is well known, diphtheria shows a great tendency to engraft itself on an already unhealthy, congested mucous membrane. The cases will serve to show the variety of conditions which may lead to laryngeal obstruction in young persons, and suggest points of differential diagnosis as well as the line of treatment to be pursued in similar cases.

The complications most frequently met with may be arranged in two chief classes :—The Immediate, and the Remote.

1. IMMEDIATE.—These are more or less of an acute character ; they come on within a few days or hours of the operation, and may not inappropriately be described as wound complications.

- (a) Diphtheria of the wound.
- (b) Inflammatory œdema of the neck.
- (c) Erysipelas.
- (d) Surgical emphysema.
- (e) Absence of reparative power.

2. REMOTE.—Generally very chronic, affecting chiefly the interior of the trachea, and manifesting themselves largely by delaying the permanent removal of the cannula.

- (a) Acute or subacute changes in the pharyngo-laryngeal mucous membrane, due to the lesion for which tracheotomy has been performed.

(Scalds, corrosive fluids, syphilis, necrosis of laryngeal cartilages, undetected foreign bodies, ulceration and granulations in trachea, &c.)

(b) Chronic catarrhal changes (including papilloma).

(c) Irritative changes due to the presence of a tube.

(d) Ulceration of trachea due to an ill-fitting tube.

(e) Unsuspected causes.

### 3. DIFFICULTIES IN PERMANENTLY REMOVING THE TUBE.

#### 1. THE IMMEDIATE COMPLICATIONS.

(a) Diphtheria of the wound.—The frequency of this complication does not seem to depend (as I formerly thought) either on the severity of the primary disease, or on unfavorable hygienic influences to which the patient may be exposed after operation. I am quite unable to offer any satisfactory explanation. In my own practice it has only occurred twice ; on each occasion it was slight but well marked. In one case, on removing the tube two days after the operation, I found the edges of the wound patched over with little islands of false membrane ; in the other case a similar condition was found ; the edges of the wound became everted, with a margin of erythema around them. In both cases I applied the hydrochloric acid and glycerine, and they recovered without further trouble. The membrane in these cases was white and characteristic ; it occurred in little patches. It is quite a distinct condition from the sodden unhealthy wound, the surface of which becomes ash-grey in colour, and secretes a thin, foetid, ichorous pus such as is not infrequently seen in severe cases of general diphtheritic infection, and to which I shall presently allude.

Almost all French authors refer to this complication.

TROUSSEAU taught that "during the first four days the entire surface of the incision should be vigorously cauterised once a day ; one may thus avoid a very redoubtable complication—the diphtheritic infection of the wound." MILLARD also, somewhat later, in his excellent Thesis, to the teachings of which I take this opportunity of expressing all my indebtedness, under the heading of 'Local Treatment' stated as a "fundamental rule" that "whatever be the condition of the wound, it ought to be canterized during the first three or four days." Such treatment is no doubt necessary under the hospital conditions in which it was advocated by these experienced physicians.

It is highly probable, however, that the term diphtheria has often been used to describe conditions which in England would be called sloughing or hospital gangrene. Indeed, SANNÉ, a distinguished "*Interne*" of the Children's Hospital in Paris, admits as much in his Thesis on Tracheotomy. He gives (p. 80), "under all reserve," a table of the cases of diphtheria of the wound observed between 1855 and 1868 inclusive ; in 252 cases of tracheotomy this complication is reported to have occurred in 72 cases. In two of the years there were no cases, and in one of the years as many as twenty-two.

This author, very properly I think, draws a distinction between diphtheria and a sloughy condition of the wound. In the latter case the surface assumes an ashen-grey colour and secretes a thin offensive pus ; but nothing like a membrane can be peeled off. Recovery can only take place after this gangrenous tissue has separated. Such a condition as this I consider directly due to "hospitalism," and I believe it is much more common in the French hospitals than in our own. I make a difference between this which is highly infectious, and may

be a purely local condition, and the following, which though local is not infectious.

(b) Inflammatory œdema about the wound to a slight extent is not an uncommon occurrence. It is more likely to occur among poor ill-fed children in unwholesome surroundings and in hospital practice than among the well-to-do patients in private practice. Among the former it may occur after a perfectly well-performed operation, though I think it is more common after operations which have presented unusual difficulties or have been performed hurriedly or by inexperienced operators. When the operation has been done on account of laryngeal diphtheria with symptoms of general blood-poisoning such a condition may assume dangerous proportions. In nearly all cases of diphtheria there is a little swelling, and the edges of the tracheal wound may for a few days assume an unhealthy condition.

In some few cases, however, this inflammatory œdema spreads far beyond the limits of the tracheal wound; it may be chiefly confined to one side of the neck, more commonly it affects both sides, and appears to be due to the gravitation of inflammatory products into and between the deeper ramifications of the cervical fascia; when it occurs on one side it will be so because the child preferentially lies towards that side, and possibly also because the inter-muscular planes have been more freely opened up on that side at the operation. It is a condition closely allied to the disease named cellulitis of the neck, or Angina Ludovici, after Dr. LUDWIG, the physician who first accurately described the disease, differing chiefly from this latter in that it is traumatic and secondary, and not spontaneous, as is the true Angina Ludovici, for a history and description of which I would refer the reader to my papers in the 'Lancet,' October 18th and 25th, 1879.



In the milder degrees this inflammation occurs in nearly all cases of tracheotomy, and especially in the asthenic form of the disease, while in a few it assumes the pseudo-diphtheritic (membraniform) character already alluded to. The normal distance from the surface of the neck to the trachea is very greatly increased by this swelling of the tissues, as may be well seen when the cannula has been removed for the purpose of being cleaned. This swelling, again, is sometimes so great that there is difficulty in retaining the cannula *in situ*, and it is well for the surgeon to be provided with tubes of varying lengths ready for this emergency.

**Case. Diphtheria—Tracheotomy—Acute œdema of neck—Its treatment—Recovery.**—J. W—, æt. 3, a pale, flabby child, was admitted, under the care of Dr. WEST, into the Hospital for Sick Children, suffering from diphtheria. In this case there was no difficulty at the operation, the trachea being rapidly and fully exposed before being incised. The child was completely relieved by the operation, and for the first few days appeared to be doing very well. But his temperature remained high. On the fourth day after the operation he was obviously less well, and there was an amount of depression which caused us considerable anxiety. There did not appear to be any chest complication to account for this. On removing the tube, the edges of the wound were found to be gaping and œdematous, and there was a copious and offensive tracheal discharge. On the fifth day an inflammatory œdema of the anterior part of the neck supervened, and rapidly increased in extent, so that the chin, neck, and sternum presented one continuous level. The tissues were brawny, and slightly reddened. There was a troublesome cough, and at each effort the tube was dislodged from the trachea, upon which a “choking fit” immediately supervened. Owing to this swelling, our longest tube barely sufficed to reach the trachea, hence it had to be constantly held *in situ* by a nurse; but the boy was, nevertheless, nearly suffocated on several occasions. Fortunately, the inflammation, having got to this stage, began to recede, and there was neither sloughing nor suppuration. We diligently applied lead lotion made with milk. One drachm of Liq. Plumbi was mixed with one ounce of fresh milk; this

mixture forms into a cream, and it was applied with a camel's-hair brush. Internally we gave tonics and stimulants. He was kept in the croup bed, and made to respire moist, warm air containing creasote. We were not able finally to remove his tube until the twenty-sixth day after the operation, and then only after many unsuccessful previous efforts. The boy remained weak and anæmic for some months after his discharge from the hospital.

I have seen this inflammatory œdema affect the whole space included between the anterior margins of the sternomastoid muscles. The neck becomes brawny and hard, pitting slightly on pressure, and of a dull red colour. On dissecting a fatal case of this kind the inflammation is found to follow the ramifications of the deep cervical fascia; the cellular tissue between the various muscles is chiefly affected, and its meshes are filled with a stinking ichor; in very severe cases the muscles themselves also become infiltrated and necrotic: the skin is rarely affected, and then only secondarily. This inflammatory process sometimes passes down into the mediastinum, and may even affect the pericardium. Some authors (TRENDELENBURG and MAX SCHÜLLER, among others) appear to think that such a complication is more likely to follow the low than the high operation. Nevertheless most of the cases of cellulitis which have come under my own observation have followed the high operation.

(c) Erysipelas.—The form of cellulitis just described must not be confounded with erysipelas, another wound complication. The latter commences on the surface and is chiefly throughout superficial, though the deeper parts become subsequently affected. The skin is reddened, may be vesicated, and it may slough; there are the characteristic raised edge and the spreading margin; it may run on to the shoulders and front of the chest, or over the face and towards the scalp. In this respect it differs from

Angina Ludovici, which is always strictly limited, and shows no tendency to spread superficially.

**Case.** Diphtheria — Tracheotomy — Erysipelas — Death from general infection.—Emily B—, æt. 3½, came under my observation in May, 1875, suffering from pharyngeal and laryngeal diphtheria. The symptoms began to manifest themselves three or four days before admission. When first seen there was erosion of both tonsils; the free margin of the epiglottis was coated with membrane, and there were scattered about the pharynx and uvula patches of greyish-white membrane. The voice was quite gone; the child much depressed; the temperature 102° F. There was no pain or swelling in the neck. Her breathing became much more laboured within the next twenty-four hours, and tracheotomy was performed. Stimulants, with bark and ammonia, were ordered. She remained drowsy and depressed. The urine contained one third albumen. Two days later, the child's general condition not having at all improved, the neck was found swollen, and around the margins of the wound there was a bright erysipelatoid blush, with two or three vesications on its surface. The wound smelt badly, and appeared indolent and sloughy. Boracic acid in glycerine was freely applied to the wound. The erysipelas was coated over and beyond its margins with collodion, and on this again lint soaked in lead and milk was laid. Notwithstanding all our care, however, the erysipelas spread, and the general blood-poisoning became more and more intense; the child died on the third day after the operation.

To all intents and purposes, however, these two last-named diseases are identical; for although their mode of onset and their exact etiology may be widely different, yet the inflammatory process once set up can hardly be differentiated. The prognosis in either case is not favorable. Even the milder forms of the disease may be considered as indicative of a low asthenic condition of the patient, while the severer forms are always associated with severe blood-poisoning. The most appropriate general treatment consists in the administration of brandy mixture or bark and ammonia to sustain the patient; as local treatment I

know of no better application than a little glycerine of carbolic acid from time to time ; it helps to destroy the infectiveness of the wound secretions, while as a constant dressing glycerine and boracic acid will be found both healing and disinfectant. To the inflamed parts around the wound I usually apply lead and milk (a few drops of Liq. Plumbi in a little fresh milk). In the severer cases, incisions may be made to relieve tension ; it is seldom that pus collects in any quantity, but the incisions give exit to a thin fœtid serum, and to the necrotic fibrous sheaths, and in this manner help to stay the spread of the disease.

If the erysipelas show any tendency to spread beyond the limits of the neck, the application of Tincture of the perchloride of iron, or of an ethereal solution of Nitrate of silver is indicated ; it should be painted over not the diseased part only, but for some distance in all directions beyond this. Then the lead lotion over this.

In all the foregoing cases I venture to think that the croup bed with its supply of warm, moist, disinfecting fresh air will be found of the greatest utility. If employed from the first I think there is much less risk of the occurrence of such complications, while in the later stages the diseases are favorably modified.

The occurrence of such conditions without may often be regarded as evidence of what is taking place within the trachea, and they are a powerful argument in favour of the local treatment of the trachea and larynx, not only with a view to prevent their onset, but also to arrest them when present. It seems somewhat remarkable that TROUSSEAU should have advocated such heroic measures to prevent the spread of the diphtheria to external parts, and yet as regards the interior have taught "that when once



tracheotomy has been performed, we need not further occupy ourselves with the pharyngeal or the laryngeal manifestations of the diphtheria which claimed such energetic treatment previous to the operation. They get well of themselves.”

(d) Surgical emphysema starting from the neck is now and then met with after tracheotomy. It is usually ascribed to the escape of air from the trachea, through an opening in the trachea which does not quite correspond with the opening in the structures in front of the trachea. Although I have many times seen the trachea incised—sometimes in more places than one before it has been quite exposed—I can only call to mind two occasions in which emphysema has occurred. I am therefore inclined to seek for an explanation in some other direction than this. It must be remembered that when tracheotomy is being performed for diphtheria or other mechanical impediment to respiration, very little air is entering the larynx, and there is therefore but very little to pass out into the cellular tissue about the neck. On the other hand, violent inspiratory efforts are being made to obtain air, and more or less of a vacuum produced in the chest as the result of not obtaining it. In this way a considerable quantity of air may be sucked into the cellular tissue if the operation be unduly prolonged; this is evidently more likely to occur when the low operation is performed. Many authors—especially German authors—have written on this subject; Dr. CHAMPNEYS also has made some interesting communications to the Royal Medical and Chirurgical Society on the subject of mediastinal emphysema with and without tracheotomy, to which the reader is referred for further details. I am the more doubtful that the air comes from the windpipe because of its harmlessness; it appears to be rapidly absorbed and to lead to

no bad consequences in the majority of cases. The following case is illustrative of this condition :

**Case.**—I was asked late one evening to see a little boy, *æt.* 2. On the previous day he had developed measles, and about the same time symptoms of diphtheria (a disease which not infrequently complicates the exanthemata). The breathing became so severely implicated that it was necessary to perform tracheotomy. The lower operation was determined upon, and proved to be a very difficult one, partly on account of hæmorrhage, and partly on account of the very rapid and laboured breathing; the tube could not be inserted. Under these circumstances I was sent for. I found the child very blue in the face, breathing rapidly and ineffectually; the trachea was partially exposed, and with each expiration a few bubbles of air escaped through the external incision; there was extensive emphysema around the neck, extending upwards towards the face. With the consent of the other surgeons present, I extended the external wound a little higher up, and, disregarding the existing opening into the trachea, incised the two upper tracheal rings as well as the cricoid cartilage, and after clearing away all shreds of membrane and the accumulated mucus, I inserted a cannula without difficulty and with complete relief to the embarrassed respiration. The emphysema completely disappeared within a day or two.

For the moment, and following tradition, I was inclined to regard the emphysema as the direct result of the escape of air through the opening in the trachea, but on further consideration, and in the light of Dr. CHAMPNEYS' experiments, it now appears to me as more probable that the air was sucked in through the incised tissue towards the close of the operation before the trachea had been sufficiently opened to permit of free respiration when the dyspnoea was at its worst, and while the patient was in the constrained position which the operation involves. I would not argue that in a few cases the emphysema may not be produced by the escape of air from the trachea; the foregoing observations apply chiefly to the case just

related. Whatever be its exact mode of production, however, the moral is the same, and needs but little emphasizing on my part.

(e) Total absence of healing power.—In a few cases, especially among poor underfed children, there will be found a total absence of all recuperative power; the wound will remain gaping, pale, and flabby, and show no sign of granulating. I have seen three or four such cases at the Children's Hospital, Shadwell. The patients come from a very poor class of the population. In the case related below every possible sort of stimulant was tried without any success. The wound could not be got to show any signs of repair.

**Case.** Diphtheria — Tracheotomy — Regurgitation of food through tracheal wound—Total absence of all reparative power—Death on twenty-fifth day after operation, and nineteenth after removal of the tube.—**Matilda R—**, æt. 3, a pale, thin, delicate deaf and dumb child, first showed symptoms of diphtheria on April 6th. Two other children of the same family had recently died of diphtheria. She was admitted under the care of my colleague, Dr. EUSTACE SMITH. The symptoms rapidly became well marked, and patches of membrane over the soft palate and tonsils with a livid ulceration were found. The glands at the angles of the jaws became much enlarged (they ultimately suppurated and discharged stinking pus). There was also a copious mucous discharge from the nostrils. On the 8th the child was hoarse; she had a barking croupy cough, and there was slight recession of the chest walls. On April 10th all the symptoms had increased in severity, notwithstanding active treatment. Mr. BATTAMS, the Resident Medical Officer, therefore opened the trachea above the isthmus; membrane was feathered up. The child appeared to go on very well for five or six days; the active manifestations of the diphtheria cleared up; there was no further deposit of membrane; the ulceration in the pharynx began to heal. The child's appetite, however, remained bad. On April 16th she quite refused all solid or semi-solid food; while liquid food passed into the pharynx and came out through the tracheotomy wound. The child was exceedingly weak and

apathetic, very pale and blanched, but free from pain or discomfort. In the chest there was some slight bronchitis; her temperature was low. Mr. BATTAMS tried feeding by means of a tube passed into the stomach through the nostril, and from April 18th she was fed in this manner entirely until her death, which took place on May 5th, of gradual exhaustion and a low form of spreading pleuro-pneumonia. The child never resisted being fed; she lay back in the nurse's arms and appeared quite indifferent; her medicine was also given in this manner. The surface of the wound looked pale; its edges were somewhat everted and flabby; nevertheless the wound did not appear unhealthy, and the discharge from it, a pale watery fluid, was quite free from odour. Various kinds of dressing were tried in turn without any good effect. This was the feature of the case; from the first the wound never showed the slightest tendency to granulate or heal.

The *post-mortem* examination revealed patches of pleuro-pneumonia scattered about both lungs. There was no erosion in the trachea.

The only other possible remedy, which was not tried in this case, was complete change of air. In similar circumstances, if such a change could be secured for a child in this asthenic condition, I should strongly recommend its being tried. In some few cases sea air has a marvellous effect. Short of this, let the child be carried out every day for half an hour's airing, the neck being carefully protected from cold by several thicknesses of gauze.

## 2. THE REMOTE COMPLICATIONS.

(a) Subacute changes in mucous membrane due to the lesion for which tracheotomy has been performed.—In severe cases of diphtheria there is sometimes found ulceration with excavation of the mucous membrane after the false membrane has been detached, a condition which may be found at any part of the pharynx or larynx. Such ulceration is usually accompanied by



swelling of the adjacent submucous tissue, and the ulcers themselves not infrequently become covered with florid flabby granulations, which are very troublesome to heal. This thickening of the submucous tissue may also be directly continuous with that in the pharynx, and independent of ulceration.

After scalds of the glottis it invariably exists for a longer or shorter period, and in greater or less intensity. It is this swelling that leads to the obstruction to breathing (not seldom fatal) which is known to occur after apparently slight scalds of the pharynx and larynx. I have under observation a boy who was tracheotomised eleven years ago for laryngeal obstruction following a not very severe scald of the glottis, to whose case I shall further refer later on.

In the laryngitis which is occasionally associated with congenital syphilis the lesion is of a rather different kind; it more resembles the mucous patches which occur in the mouth and about the lips. The mucous membrane is thickened and raised owing to its infiltration with cells; the submucous tissue of course partakes more or less in the change. In older children occasionally a destructive phagedænic ulceration may occur either primarily in the larynx, or by extension from the arches of the palate or epiglottis, or from the wound.

In perichondritis such as is met with in a few cases as a sequela of typhoid fever and of other febrile conditions, the inflamed mucous membrane is symptomatic of deeper changes rather than a primary condition; its course, clinical manifestations, and treatment will depend on the primary lesion. A form of laryngitis occurs also occasionally after febrile conditions, and the exanthemata, apparently due to the breaking down of exudative material which has collected in the glandular structures of the mucous mem-

brane, probably of the same nature as typhoidal ulceration in the intestines.

These local conditions, which may all give rise to dyspnœa and necessitate the performance of tracheotomy, will generally persist for some time after the operation ; the surgeon is usually brought face to face with his case when the dyspnœa is so urgent that the operation must be performed at once, and the diagnosis made afterwards. It is in such cases that the foregoing conditions become complications, the full significance of which will only become apparent at the end of a few days, when, the urgent dyspnœa having been relieved, the question of removing the cannula begins to present itself.

The diagnosis of the various conditions is not very difficult, but it is essential to successful treatment. The chronic œdema, which diphtheria occasionally produces, may be suspected in the larynx if respiration through the glottis is delayed for some time after the general disease has subsided, and more especially if a similar condition has been seen about the tonsils or palate or external wound. The expectoration of bits of membrane or of pellets of inspissated mucus with shreds of necrotic submucous tissue attached and blood-stained on the deeper surface occurs from time to time, and makes such a diagnosis almost certain. In most cases of this kind among young children there will be considerable delay in laying aside the silver tube ; if the child be poor and ill-nourished this chronic ulceration may heal very slowly, and months may pass before the laryngeal function is re-established. In syphilis, which has often to be diagnosed by a process of exclusion, improvement will rapidly set in on an anti-syphilitic treatment, while the condition will remain stationary or become aggravated if merely treated by general remedies. Apart, however, from this method of

diagnosis there may be a history of congenital syphilis, and perhaps also evident syphilitic lesions of other organs ; thrush in the mouth, snuffing, condylomata about the anus, local thickenings on the long bones or bones of the skull. Any such signs would be in the highest degree suggestive of the probable nature of the laryngeal lesion, if laryngeal obstruction were found associated with one or other of the above-named conditions. In doubtful cases a mercurial course can be tried if the laryngeal urgency is not very great ; a few days at most will suffice to test the value of such treatment. Finally, it must not be forgotten that diphtheria may supervene, as a complication, on these foregoing conditions ; that indeed chronic inflammatory conditions of the larynx and pharynx rather predispose to attacks of diphtheria.

I recorded an interesting case of this kind in the 8th volume of the 'Clinical Society's Transactions' in 1875. A little girl aged three years sustained a scald of the glottis from drinking out of the spout of a tea-kettle, containing boiling water. For three or four days there was no serious difficulty in the breathing, nor signs of general illness ; the child slept fairly well, but complained of local pain. Then she began to breathe more rapidly, and some general malaise set in. About the sixth day breathing became laboured. Tracheotomy was performed, when some characteristic membrane was got up. I argued in this case that the parts most affected were furthest away from the action of the hot stream, and that her disease was ordinary diphtheria, engrafted upon an abraded and inflamed mucous membrane. Had the dyspnoea been the direct result of the scald, the difficulty in breathing would have been manifest at once, or shortly after the accident ; whereas not less than six days elapsed. This is a very usual period of incubation in diphtheria cases.

The treatment of such cases depends upon the cause. The action of corrosive fluids and of hot steam or water varies with the amount swallowed, with the nature of the fluid, and with the heat of the water or steam. Occasionally diphtheria, as in the case just related, may attack a throat so injured, in which case treatment will have to be in accordance with the principles already laid down. If the laryngeal cartilages become diseased they will have to be removed, and the ulceration of the adjoining mucous membrane will probably not begin to repair until their removal is accomplished; furthermore, the necrosed cartilage may become detached and fall into the air-passages unless it is removed.

For the purposes of local applications, whether disinfectant, astringent, or solvent, to the throat, nothing is so effectual as a good spray. I would especially urge the value of a steam spray. The greater power of this over a hand spray ensures a finer pulverisation of the fluid which is being used, and it is thus more easily and more thoroughly brought into contact with every part of the diseased membrane, even up in the posterior nares. In cases of diphtheria where solvents are being used to destroy false membrane, a steam spray is of first importance. By causing the patient to inhale through the larynx, or making him attempt to do so, the spray reaches the glottis and materially assists in getting rid of the viscid mucus or membrane which tends to collect at this spot.

Occasionally, however, strong solutions of nitrate of silver are required, and these of course cannot be sprayed in. For such cases I have found the little instrument figured opposite useful. It can easily be made, and bent to any angle most convenient to the requirements of the case. It consists of a piece of glass tubing bent in the



flame of a spirit lamp to the required shape, to the end of which an india-rubber mouthpiece is attached. When about to be used, a little nitrate of silver solution of the

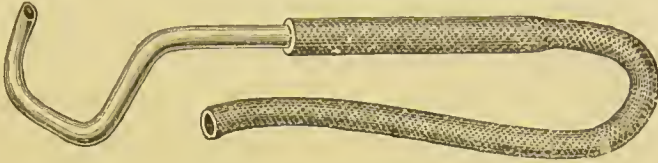


FIG. 18.—An instrument for applying solutions to the larynx through the opening in the trachea.

required strength is put into it ; the pointed extremity is passed through the tracheal wound up to the larynx, and the fluid is blown out through the india-rubber tube. By its use the fluid is brought to bear directly on the part affected.

(b) Chronic catarrh.—In children, the chronic conditions which may demand tracheotomy are—(1) chronic laryngitis, and (2) warty laryngitis (papilloma). From a consideration of the pathological anatomy of these conditions it will at once be evident that obstruction to the breathing may sooner or later come on, and how and why a little fresh catarrh or the occurrence of an exanthem or of whooping-cough may suddenly render these conditions of very serious import, and introduce an element of danger which will be great in proportion to the youth of the patient. (1) Chronic laryngitis is usually secondary to an acute attack ; and when it attacks the larynx, in a majority of instances it is by direct extension from the pharynx, or it depends on some constitutional peculiarity. Chronic catarrh leads to enlargement of the racemose glands and to general thickening of the mucous membrane and submucous tissue ; the calibre of the larynx

and trachea is thus narrowed ; moreover, there is increased secretion of mucus, which is very tenacious, hard, and difficult to cough up. Owing to their small size in early life, stridor and dyspnœa quickly supervene on the slightest exacerbation of the conditions—such as that produced by simple catarrh, for instance. In other cases the onset of dyspnœa is very gradual ; it is at first most obvious during the night when the child is asleep, and little by little as it progresses sleep becomes much disturbed. The stridor then becomes audible during the daytime, and is worse after crying or emotion of any kind. On examining the chest, the soft parts will now be found to sink in with respiration, and in children old enough to talk an alteration in the tone of the voice will become noticeable. Gradually the breathing becomes more and more laboured, and the voice, which is hoarse from the first, is finally suppressed. The following is a typical case :

**Case.** Chronic laryngitis — No obvious cause — Urgent dyspnœa — Tracheotomy — Difficulty in removing tube — Recovery.—C. B—, a little boy æt. 4, was readmitted into the hospital on account of an increasing dyspnœa. He had already been under observation a few weeks previously for the same condition, for which he had been successfully treated with iodide and bromide of potassium, and local astringents. The condition had come on so gradually that the exact date of its first onset could not be fixed. At first it was chiefly noticed at night, then became evident during the day ; there had, however, been slight exacerbations from time to time whenever the boy cried or caught cold ; his voice had been hoarse for some time past. At the time of his readmission his symptoms were almost urgent ; his pharynx on examination was swollen and congested ; the epiglottis also appeared thickened ; the voice was hoarse and half suppressed, and he spoke with great effort. He was immediately placed in a croup bed, and sedatives were added to the warm moistened air he was made to breathe ; after a while he improved slightly. His dyspnœa was always worse at night ; for two or three nights after his admission, between 11 p.m. and 2 or 3 a.m., the breathing was

so laboured that tracheotomy seemed unavoidable. However, towards morning the violence of the attack passed off, and he slept in comparative ease. Matters continued like this for a week, and as there was no permanent improvement in his condition, tracheotomy was performed. Subsequently he did well; his anxious, careworn expression gradually wore off, he slept soundly, his appetite and spirits and strength returned. I need not detail all that transpired within the next three months, during which he had to wear his tube. We tried his breathing power on several occasions, but he could not get on for very long without his tube. The boy was of a highly nervous temperament, and he greatly dreaded its removal. A subterfuge was finally adopted; a window was cut in the tube just at the angle, and the external orifice was corked; this obliged the boy to breathe through the glottis, while the presence of the tube in the trachea lessened his nervous agitation. To this he gradually accustomed himself, and little by little also he learned to sleep with the tube corked. Meanwhile his throat was sprayed with astringent applications, and the sub-inflammatory condition at last subsided; the boy also grew considerably. Finally, after many failures, we succeeded in removing the cannula; but his inspiration continued noisy for many months, though it had ceased to be laboured. His general treatment consisted in a liberal diet, with cod-liver oil and steel wine.

In many similar cases which I have seen at various times, the nocturnal exacerbation of symptoms has occurred; the crisis is reached between two and three o'clock in the morning; the difficulty then appears to have expended itself, and comparative ease and quietness follow.

(2) Warty laryngitis, though a rare condition, occurs with sufficient frequency to merit a notice in this connection. It is usually slow in its progress, but urgent symptoms may come on at any time as the result of catarrh or cough. Sir M. MACKENZIE, in his work on 'Diseases of the Larynx,' p. 300, says, "Chronic congestion of the laryngeal mucous membrane is, far above all other causes, the most important etiological feature in the production of simple morbid growths in the larynx." In

the following two cases there was no very manifest cause, but the social surroundings of the patients were just such as would favour the onset of chronic catarrh in children with a predisposition thereto. I am inclined to attribute greater weight to personal predisposition than to chronic congestion, which is itself a morbid condition. Among poor children chronic laryngeal catarrh (chronic congestion) is common, while warty laryngitis is very uncommon. Warty laryngitis is occasionally congenital; I have myself seen one or two instances in the bodies of children who have died of other complaints, and before the local condition had had time to manifest itself.

**Case.** Laryngeal catarrh—Increasing dyspnœa—Tracheotomy—Warts seen on vocal cords through tracheal wound—Perfect relief by operation—Pneumonia three months later—Death—Autopsy.—W. C—, aged twelve months, was a small, careworn-looking child when he first came under observation. The mother's account was that the disease began nine months previously, when the child was between three and four months old; she thought he had caught cold. This was followed by wheezing. Six months ago (at Christmas-time) the child lost his voice, his cough became croupy, and he began to breathe with stridor. This stridor gradually became more marked, and during the last four months it had been so bad during the night that the child had only been able to sleep for very short periods during the whole of this time. There was no history of phthisis nor anything reliable of syphilis. When first seen he was greatly emaciated and looked exhausted. The child seemed drowsy and tried to sleep, but the difficulty of breathing roused him at once. The breathing was very laboured and stridulous, the cry almost inaudible. With each inspiration there was recession of the epigastrium and of the episternal region; expiration was comparatively easy. The fauces were congested; the tonsils also, but not enlarged. The skin was of a livid pallor. The child was put into the croup bed, and steam, with creasote vapour, was turned in. There was no amelioration; on the contrary, at five o'clock in the



morning, the breathing having become exceedingly laboured, tracheotomy was performed. The relief was immediate and complete. On examining the trachea through the wound, held open by double blunt hooks, a crop of sessile warts could be distinctly seen on and about the vocal cords. A cannula was then put in, and the child returned to bed, when he slept soundly for some hours. Within a few days general improvement set in. He could now sleep well, and he took food with relish: the wound in the neck healed, save a channel for the tube, which we did not even try to remove under the circumstances. For two months the child thrived; then he got pneumonia and died rapidly.

In this case the history pointed clearly to a chronic condition, and all doubt as to its real nature was set at rest by the examination of the larynx at the time of the operation. The child was so young and so small that the question of thyroto-my was only entertained to be discarded, for apart from the serious nature of the operation, the scattered sessile condition of the growths would have added materially to the difficulties of the operation. The condition of the larynx, as found after death, is depicted in Fig. 19. Microscopically these warts were found to consist of delicate nucleated fibrous tissue.

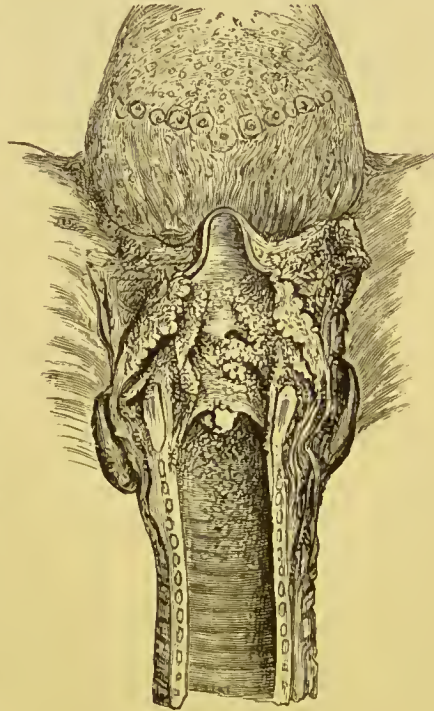


FIG. 19.

Our attention was chiefly directed to the general health, which had suffered very much from want of sleep. We were especially careful to provide him with a well-fitting tube. This was changed

from time to time, sometimes a long tube, sometimes a shorter one, being used. As will be seen, there was no ulceration from the tube below, but above a quantity of graulation tissue had formed itself into something like a membranous diaphragm, which easily broke down when touched.

Another case of papilloma of the larynx has since come under my observation. The history of the case differs considerably from the last; the child was older, but the exact nature of the obstruction was not made out, I regret to say, until after death.

Case. Chronic laryngitis—Progressive stridor—Dyspnœa—Tracheotomy—Measles three months later—Death—Autopsy—Papilloma of larynx.—Annie D—, æt. 3½, was admitted into the East London Hospital for Children in November, 1882, under the care of my colleague, Dr. DONKIN, with a history "that she was well one day and her voice gone the next." The condition of the voice was slowly getting worse week by week, but she was not ill in herself. On admission, the breathing was stridulous and the voice hoarse; there was recession of the soft parts of the anterior part of the chest. The tonsils were very large; they almost met in the middle line. The diagnosis was chronic catarrhal pharyngo-laryngitis. Every kind of treatment, both local and constitutional, was tried for some weeks without any good effect; her voice gradually became weaker, and her dyspnœa more severe. During an attack of pneumonia, from which she suffered in the following February, her dyspnœa became so urgent that Mr. BATTAMS, the Resident Medical Officer, had to perform tracheotomy. She went on well and seemed relieved of all her dyspnœa, but the voice in no way improved. Many attempts to remove the tube were made, but were unavailing. In process of time she was got up and allowed to play about the ward, and in suitable weather she went out into the garden. In May she caught measles, which was then epidemic in the neighbourhood, on which broncho-pneumonia again supervened, and she died on May 26th, still wearing her tracheotomy tube. The autopsy revealed extensive pneumonia, and the condition of the larynx is depicted in the annexed drawing. It will be seen that there

are two large cauliflower-like warts on the left vocal cord, with a crop of smaller warts on the right cord, and scattered about the larynx generally. There were some small flabby granulations around the inner orifice of the tracheotomy wound, but no ulceration in the trachea. The condition is shown in the drawing, Fig. 20.

In this case a correct diagnosis would have been of interest, and possibly of service, but the history was insufficient for the purpose; the condition of the tonsils and pharynx precluded the use of laryngoscope, even had the age of the patient not done so. But a diagnosis might probably have been made from the tracheal wound at the time of the operation had the attempt been made. It is even possible that the warts might have snipped off; at any rate, the larger warts, which were more or less pedunculated,



FIG. 20.

could have been removed without much difficulty. It is, of course, very doubtful whether the smallest ones could have been removed, but it is equally doubtful whether they were present at the time the tracheotomy was done.

I am inclined to think they may have grown subsequently in response to the long-continued irritation of a mucous membrane having warty proclivities. Such cases, when they can be diagnosed, should be taken in hand at



once. Nothing is gained by waiting; the warts spread, they grow larger, and every subsequent operative interference beyond the first one adds to the dangers and uncertainties of the case.

In another case a correct diagnosis was made; thyrotomy proved quite successful. I removed an immense crop of warty excrescences, which appeared almost to fill the larynx.

**Case.** "Gruffy" voice from infancy—Progressive stridor since *æt.* 3—Dyspnœa—Thyrotomy—Recovery. —Martha G—, *æt.* 4 years and 9 months, was stated to have always been "gruffy" since she began to talk; this "gruffiness" had been constant; she had not had measles or scarlet fever, and had not been subject to catarrh. About Christmas-time, nine months previous to my seeing her, the gruffness suddenly got worse, and her voice entirely disappeared. She had not complained of any pain, or soreness in the throat, and had no difficulty in swallowing. This condition remained for six months unaltered; then she began to "snore" at nights—which was found to mean that she breathed noisily, and she became increasingly restless at nights. For a few days she had been feverish, and had had an almost constant cough. On examination she proved to be very thin, but was well grown for her years. The tonsils were large; the pharynx rather red and inflamed. There was considerable recession of the soft parts of the chest-wall; breathing was laboured; the heart was normal; skin hot; no eruption. There was no improvement after three or four days in bed. Thyrotomy was performed; large pendulous masses of papillomatous growth were removed from each vocal cord, and sessile growths from the adjacent mucous membrane below them. The child made a good recovery.

I have quite recently seen this patient. Her voice is still very gruff, but it is now stronger than it has ever been before.

(c) Irritative changes due to the presence of a tube.—In a few cases the mere presence of a tracheotomy tube in the trachea, even when perfect as regards length, shape, and size, appears to give rise to an



irritation which is quickly followed by the growth of granulations. A considerable amount of granulations has been found in from four to eight days in cases which have terminated fatally. Such a condition may be suspected if the insertion of the tube appears to cause undue irritation, and especially if its insertion is followed by blood-stained secretion. In cases where the granulations about the external wound proliferate with unusual exuberance, such a growth may be suspected within. This peculiarity seems to depend on a hypersensitiveness of the tracheal mucous membrane, and it is an idiosyncrasy which must be taken into account. Minor degrees of this condition are often experienced, some tracheotomised children never reconciling themselves to the cleaning and changing of the tube.

If granulations spring up, the best treatment is the local application of nitrate of silver. A silver probe, after being suitably bent and coated with fused nitrate of silver, is introduced into the tracheal wound, and made to touch as nearly as possible those parts on which the tube has rested. Or a few drops of thirty-grain solution of nitrate of silver may be allowed to trickle into the trachea, the child sitting upright and inclined slightly backwards, so that the solution may run over the affected portion of the trachea.

The granulations I am now alluding to may occur all round the trachea, and not merely on the anterior wall or at one spot; for they are not due to pressure, but, as before stated, to the presence of a foreign body in an unusually sensitive trachea. I append the drawing of a trachea (Fig. 21) in which granulations due to this cause were very abundant over the whole track of the tube. There was no sign of ulceration; the granulations occurred within five

or six days of the operation. The child appeared to be doing very well, until one night it was suddenly choked after a violent fit of coughing.



FIG. 21.

The autopsy revealed the presence of granulations between the tracheal wall and the tube, which doubtless during life were florid and turgid with blood, and completely filled the space; one currant-like granulation, larger than the rest and attached to a small pedicle, had apparently been driven by the coughing into the tube and completely occluded it.

In the case of warty laryngitis—that is, when there is a natural tendency to the formation of warts—the irritation of a tube leads to the production of minute warts, instead of granulations proper, as seen in Fig. 21, below the tracheal opening. In the case of granulations proper, some difficulty is usually met with in the removal of the tube. At first sight the obvious remedy is the removal of the cause; but an acute obstruction having necessitated the use of the tube, granulations having occurred and actually existing, the difficulty arises of how best to treat them.

Such cases all point to the desideratum of tracheotomy without the use of tubes at all. At present I have not been able to dispense with them; nor do I know of any trustworthy means of gaining the desired end without tubes; at the same time it is a desideratum I constantly have in mind, and which I recommend to the consideration of my professional brethren.

As to treatment, reference has just been made to the use of nitrate of silver once a day, or once in two days. Alum solution (half an ounce of glycerine of alum in eight ounces of water) or resorcin solution (5—10 per cent. in water, with a little glycerine added) may be sprayed into the throat at intervals. This will tend to destroy the granulations and promote healing. The tube should be removed for as long as possible, and the silver plug inserted, the patient being meanwhile under direct supervision; for on the removal of the tube the granulations swell out, and if present in quantity they in time occlude the trachea. Hence a child will often breathe well for an hour or two, then the tube must be reinserted. The explanation appears to be as follows:—The tube by its presence keeps back the granulations, but having been removed, they commence to swell up; possibly also the more laboured breathing (which follows the removal of the tube), by causing congestion, helps them to still further occlude the trachea. Should these measures fail, intubation may be resorted to.

(d) Ulceration in the trachea, due to an ill-fitting tube.—This condition is now of much less frequent occurrence than formerly. M. ROGER was the first to draw prominent attention to the subject, and to suggest at once the cause and the remedy.\* As I have no personal cases to relate, I must summarise M. ROGER's views and conclusions. He showed that the complication was more liable to occur in some cases and in some epidemics than in others; but from the anterior wall being most affected, and just at the place corresponding to the lower extremity of the tube, he argued that the chief cause of the ulceration was pressure of the tube, “*l'action vulnérante*

\* ‘Archives Générales de Médecine,’ 1859, vol. ii.

de la canule.” This condition is most to be feared when the tube has to be worn for a longer period than usual, but it has been found as early as thirty-six hours after the operation.

The ulceration may be only superficial, or it may be deep enough to perforate the trachea ; and, as cases are recorded in which the innominate artery has been opened, it will be allowed that this complication is a very formidable one. As symptoms of this form of ulceration, M. ROGERS gives the following :—It is to be suspected if the external wound assumes a sloughy condition, and if the breath and expectoration re-become fœtid ; the tube may be found blackened, either entirely or in patches ; and there may be pain or difficulty in swallowing. Most of these symptoms, however, may occur without the presence of ulceration, as I have seen on many occasions. The difficulty of recognising the onset of this ulceration, no less than its dangerous nature, renders it incumbent on the surgeon to watch his patient closely on the one hand, and on the other only to use such tubes as are comparatively safe and unlikely to press on the trachea.

M. ROGER tried different materials—gutta percha, india-rubber, flexible ivory ; but finally discarded them in favour of silver, recognising that the ulceration depended on the unsuitable shape of the tube, rather than on the fact of its being rigid : “ *La forme des canules habituellement en usage n’est pas celle qui conviendrait le mieux.*” After many unsuccessful trials, M. ROGER finally adopted LÜER’S tube with the moveable collar.

While admitting the immense improvement which was thus effected, as already stated I am inclined to think that much of the mischief was really due to the quarter-circle shape of the tube itself. I must refer the reader back to what has already been said on the subject of



tubes. Since using the "angular" tube, I have not had any cases of ulceration to report.

Cicatricial narrowing.—Narrowing of the trachea is occasionally met with; its occurrence is not uncommon after tracheotomy, where there has been much sloughing or destructive disease, either in the trachea or around the incision into it. I have seen one case where stridulous breathing, years after the operation, probably indicates this pathological condition. It occurs also after scalds of the pharynx and upper part of the larynx. One patient of mine wore a tracheotomy tube for eleven years before he could breathe without it. The treatment of such cases, to be of any avail, must commence early; even then it is not very satisfactory. It should consist in the passing of graduated bougies, hollow, so that respiration can be carried on during the process of dilatation. Other measures failing, intubation must be tried. I shall elsewhere speak of this method.

(e) Unsuspected causes.—Under this heading I shall include two cases, which, though not by any means unique instances, are nevertheless so rarely met with as to require separate consideration. They appear so purely accidental in their incidence that none but the most general precautions can be taken to guard against them.

Case. Catarrhallaryngitis—Tracheotomy—Difficulty in removing tube—Hypersensitiveness of the trachea—Death in convulsion fifteen days after removal of tube—Autopsy—Large granuloma at the seat of cicatrised wound inside the trachea.—Eliza M—, æt.  $2\frac{1}{2}$ , was admitted into the hospital under the care of my colleague, Dr. EUSTACE SMITH, on February, 1882. She was one of eight children, of whom one had recently been suffering from quinsy. She had enlarged glands about the neck, secondary to eczema capitis, to which disorder she was very subject. She was a plump, well-nourished child, and well-

grown for her age, with no very manifest signs of rickets. On admission she was said to have been hoarse for two days; she had that morning complained of having "a pin in her throat." She had had no discharge from her nose, and there was no illness in the house. Her breathing had become so laboured by the following day that tracheotomy had to be performed by Mr. BATTAMS; the high operation was done; chloroform was administered by Mr. SANDERSON, one of the resident officers. No membrane was got up or seen. The child did fairly well; efforts to remove the tube, however, were not successful until March 15th, thirty days after the operation. It was remarked at the operation, as well as subsequently, that the child's trachea was remarkably sensitive; she coughed violently whenever it was necessary to clear the tube or attend to the wound, and one of the difficulties which attended the attempts to remove the tube appeared due to this hypersensitiveness of the tracheal mucous membrane. Finally, the tube was removed, and the external wound gradually closed up. The child breathed fairly well in the daytime, but had attacks of urgent dyspnoea, becoming progressively worse during the nights, with some nights

of comparative immunity. The voice was not hoarse. On March 31st, forty-six days after the operation, the child died in a convulsion after an attack of dyspnoea rather worse than usual. The trachea was again opened, but too late to save life. The autopsy revealed the condition depicted in Fig. 22. At the site of the old tracheal wound there was found a highly vascular livid mass of granulation, more or less pedunculated, projecting into and considerably narrowing the trachea at this point. The ary-epiglottic folds were very œdematous.

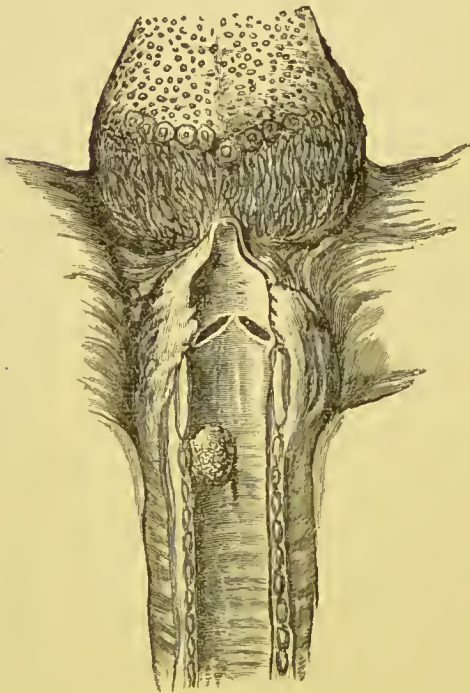


FIG. 22.

In this case the laryngo-tracheal mucous membrane was exceedingly sen-

sitive, and doubtless also somewhat œdematous. Thus breathing was rather more laboured than normal after the tracheal tube had been removed. The granuloma doubtless gradually developed and increased in size, and finally, during an unusually severe paroxysm of laboured breathing, it became extra turgid, and so completely occluded the cricoid opening (which is the narrowest part of the windpipe), and thus killed the child. A fatal termination to a case of tracheotomy from this cause may be regarded as a rare event.

Dr. PETEL, in his graduation Thesis,\* only collected ten such cases in addition to the one he himself recorded. In three of the cases a second operation was performed with complete success. In one case the child was tracheotomised three times, and had still to wear the cannula. In another case the polypoid granulation was spontaneously coughed up. In three cases death resulted before help could be given. In two cases the condition, which had not given rise to any symptoms, was only discovered at the autopsy, death having taken place from some other cause. In a minor degree, nevertheless, I am inclined to think that such a condition is not very uncommon. There are no *à priori* grounds why granulations should not spring up on the deep surface of the wound as they do on the superficial. On the latter granulations, sometimes very exuberant, are the rule. From a study of the published cases it appears that the granulations have most frequently grown from the upper angle of the wound—that is to say, immediately below the cricoid opening, the point where their presence would be most dangerous. The possibility of such an occurrence has even been urged, but I think the grounds very insufficient, as an argument

\* 'Des Polypes de la Trachée, survenant après Cicatrisation de la Trachéotomie,' Thèse de Paris, 1879, No. 500.

against the high operation. This condition may be suspected—the patient having previously undergone tracheotomy, the tube having been removed, and the wound being more or less cicatrised—if the breathing again becomes gradually and temporarily embarrassed, the voice generally remaining unaffected. At first this embarrassment will be chiefly obvious at night, when the child is asleep; then during the daytime also. It will be paroxysmal, and vary much in intensity; in the later stages expiration will be as much impeded as inspiration (or more); there will probably be blood-stained expectoration, especially after paroxysmal coughing. It is probable also that the external wound may have exhibited a tendency to exuberant granulations.

Given such signs, what is to be done under the circumstances? The surgeon will have to be guided by the intensity of the resulting dyspnœa; if it tends to improve slowly, the use of the alum or tannin spray may be continued; if it tends to become more marked intubation must be tried; and if this fails, then a second operation will have to be undertaken and an examination of the part made, with a view to the removal (if present) of the granulations by forceps, caustic, or otherwise. In his interesting graduation Thesis Dr. CARRIÉ\* says, p. 63: “In these circumstances, with difficulty [of breathing], recession, noisy breathing during the night, we must not await a first access of suffocation, which may prove fatal, but at once reopen the trachea.”

**Case.** “Croupy” cough—Urgent dyspnœa—Tracheotomy—Inability to remove the cannula—Sudden death three months later—Autopsy—Web-like adhesion between the cords.—A little boy, eighteen months

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\* ‘Contribution à l’Étude des Causes empêchant l’Ablation définitive de la Canule,’ Thèse de Paris, 1879, No. 13.



old, came under observation on account of a "croupy" cough and dyspnoea, which subsequently necessitated tracheotomy. No membrane was got up. At the end of a week attempts to remove the tube were commenced. They were quite unsuccessful, and remained so. The child's general condition was good, and he appeared well in all respects except that he could not get on without his tube. One night he was found dead in bed. No sound had been heard by the night nurse, who had just previously looked at him and found him sleeping comfortably. The bedclothes were quite undisturbed. His eyes were closed, and his features free from any sign of a death-struggle. The autopsy revealed the following condition:—The lymphatic glands, tonsils, follicles of the pharynx, and root of the tongue were very much enlarged. On the anterior wall of the oesophagus, opposite the shoulder of the tube, there was an oval diphtheritic patch three quarters of an inch long, corresponding with a similar condition on the posterior wall of the trachea. Looking into the larynx from above, the vocal cords were seen to be much swollen. Looking up the trachea from below there was no visible passage; in fact, immediately above the tube there was a diaphragm of granulating and cicatrising tissue, which had a short, unattached margin opposite the posterior wall of the windpipe and nowhere else. This septum would impede inspiration greatly and expiration altogether. There was great ulceration of the mucous membrane opposite the end of the tube.

Had such a condition as this occurred in an older child it is just possible that the web of new growth might have been seen by means of the laryngoscope, and then measures might have been concerted for its removal. During the course of the case bougies had been passed through the glottis without difficulty and without encountering mechanical hindrance, and thus the condition which was found after death was quite unexpected. This case occurred many years ago; were such a one to occur now intubation would probably be deemed the right treatment to adopt; whether success would follow, or not, cannot be safely predicated.

Foreign bodies.—The undetected presence of a

foreign body near the glottis is sometimes a source of trouble after an operation which has had to be hurriedly performed, and in which the history of the cause and the mode of onset are not clear. In young children the diagnosis is often very difficult, for a laryngoscope can only seldom be used. Even when the history points to the presence of a foreign body as the probable cause it is not always possible to detect it. In this respect the following two cases are interesting. I had the opportunity of observing both, but they were not actually under my own care.

**Case.** Sudden dyspnœa—No appreciable cause—Tracheotomy—Death in convulsions—Autopsy revealed the presence of a bit of eggshell in the larynx.—A small child was taken suddenly with laryngeal symptoms, and with urgent inspiratory dyspnœa, while playing about apparently in excellent health. It was brought to me shortly afterwards; the child was greatly distressed, breathing with difficulty, and sweating profusely in consequence; the angles of the mouth were drawn down at each inspiration. Tracheotomy was performed shortly after its return home, and gave perfect relief. A few days later attempts were made to dispense with the tube, but were quite unsuccessful. During one of these trials the child died in convulsions. At the autopsy a small piece of eggshell was found adherent to the side of the larynx.

**Case.** Sudden dyspnœa—Fishbone suspected as the cause—Tracheotomy—Measles—Death—Autopsy—Impaction of bone in the glottis.—A little boy, aged eighteen months, was taken with sudden dyspnœa while or shortly after eating fish for dinner. The cause was immediately suspected, viz. that he had swallowed a bone. He was brought to the hospital, where a most careful search with the finger was made in the pharynx and upper part of larynx, but without success. Tracheotomy had to be performed. After its completion another search for the suspected bone was made, but with no better success. The boy did well after the operation, except that his temperature remained high. Frequent attempts to remove the tube were made; he could neither phonate nor in-

spire through the glottis. An attempt to see the larynx with the laryngoscope was also unsuccessful. A catheter could be passed into the mouth through the tracheal wound, but the child continued quite unable to breathe without his silver tube. About three weeks after the tracheotomy the child developed measles, which was very prevalent at the time, and died of lung complications. At the autopsy the glottis was found quite closed, and a long slender fishbone between the cords. The upper extremity of the bone projected into the pharynx.

These two cases are of interest as showing the difficulties which sometimes beset diagnosis as well as treatment. In such cases, the number of failures will certainly be lessened if feathering out the glottis at the operation, as advocated in a preceding chapter, be practised as a matter of routine in all cases. But whether this plan be adopted or not, it may be laid down as a canon of surgery, when tracheotomy has been performed on account of a suspected foreign body, that the persistence of the symptoms points to a persistence of the cause.

Little is gained by procrastinating in such cases ; further treatment must be tried.

The following case is interesting in many points. Though several cases of fatal dyspnœa from the same cause have been reported, no case that I know of has presented quite the same ensemble of symptoms.

**Case.** Urgent dyspnœa in an infant aged twelve months, occurring suddenly, and terminating fatally within one and a half hours, due to a caseous gland which had ulcerated its way into the trachea.—The patient was an infant in arms, and previously to the onset of the dyspnœa was believed to be in perfect health. The mother at the time was in a butcher's shop buying meat for her husband's dinner; suddenly, and without any obvious reason, the baby was seized with urgent dyspnœa. The mother ran off to the nearest doctor, who, recognising the urgency of the case, sent it on to the East London Children's Hospital. Meanwhile, the dyspnœa became extremely urgent, and tracheo-

tomy was performed by the resident medical officer (Dr. Hastings). Some temporary relief was afforded; but a foreign body which was believed to be the cause of the trouble could not be found, nor any other satisfactory explanation for the dyspnoea. The child died within one and a half hours of the commencement of the attack. At the post-mortem examination a caseous gland, which had ulcerated its way into the trachea, was found just above the bifurcation, occluding one bronchus entirely. There had been no symptoms to attract attention to such a condition.

The full details of the case are recorded in the 'Clinical Society's Transactions,' vol. xxiv.

DIFFICULTY IN PERMANENTLY REMOVING THE TUBE.—The one complication common to all the cases just recorded was difficulty in removing the tube. In some of the cases this depended on mechanical causes such as would not in the nature of things be remedied by tracheotomy; while in others the difficulty arose from conditions which were mechanical and secondary to the primary lesions. In some the difficulties were not anticipated, in other cases experience taught us that difficulties might arise.

There still remains a class of cases in which this same difficulty occurs and persists a long time, and is not adequately explained by mechanical obstruction alone. The following is a typical case:

Case. Diphtheria—Tracheotomy—Chronic pharyngitis—Delayed removal of tube—Scarlet fever—Albuminuria—Change of air to the sea-side—Recovery—Tube finally removed 175 days after operation.—M. T—, æt. 2, a very delicate child, was tracheotomised on account of severe diphtheria. Other members of the family had suffered, though in a varying and less severe degree. The child had previously been treated with emetics. The operation afforded immense relief; flakes of membrane were spontaneously coughed out, as well as wisped out with a feather. On the day after the operation he had a troublesome hacking cough, which



much exhausted him. He was accordingly chloroformed, the tube taken out, and the larynx and trachea were again carefully cleaned out, after which the tube was again inserted. Benzoin inhalations were then ordered, and he was much relieved for a time. The cough, however, returned from time to time, and a few whiffs of chloroform were given through the tube, shortly after which it passed off.

On the fourth day after the operation the larynx was tried, and considerable breathing power found to be present. On the sixth day, with the tracheal wound closed, he spoke a few words quite distinctly. On the twelfth day little or no progress had been made. On the seventeenth day he could inspire a little and expire freely when the tube was out.

On the twenty-fifth day the tube was removed, and kept out for fifty minutes, the external wound being closed, without producing any great amount of distress, after which it had to be replaced. On the twenty-seventh day, and without any obvious change in the boy's condition, he could not breathe at all through the larynx, and the tube, which had been removed for the trial, had to be replaced very hurriedly. The boy's general health had been improving daily, and he was taken out when the weather permitted.

We continued to make these trials with a varying amount of success. Several differently-shaped tubes were made for him; some with, others without, a window, and the length as well as the curve was altered, so as to avoid intra-tracheal erosions.

When two months had elapsed, the external wound having cicatrised, except a narrow channel for the tube, a new complication set in. On removing the tube, this channel into the trachea (which was lined with young cicatricial tissue) gradually closed, so that after about an hour it was difficult to reintroduce the tube when the state of the breathing rendered it necessary. I therefore used a plug made of gutta percha (Fig. 23, p. 164).

This plug just reached into the trachea, and so prevented closure of the external opening; but it was not long enough to interfere in any way with the respiration. We also had recourse to a short tube corked at its external orifice, with a large window in its convexity; the boy was thus made to breathe through his glottis. Thus we continued for another month, making way very slowly indeed. Although he got on well enough in the daytime, he could not sleep a wink at night without his tube. Galvanism of the muscles of the neck was tried without any good effect.

Exactly three months after the operation he contracted scarlet fever. Although there was no dangerous faucial complication, there was sufficient inflammation to undo all that we had gained during our attempts to remove the tube; in fact, we found it obligatory to desist from these attempts. At this time we had the advantage of a consultation with the late Dr. MURCHISON. When the fever was over, we recommenced our attempts to get rid of the tube, working exactly on the same plan; and, as before, with varying success. I may sum up by saying that the boy could breathe through his glottis with comparative ease (and could talk with considerable distinctness) while awake, but not at all when he fell asleep. In the fourth week after scarlet fever albuminuria supervened, and he became very low and ill. Somewhat later on he had a severe cough, and his temperature was high—on one occasion  $105^{\circ}$  F. Dr. ORD now gave us the benefit of his assistance. We feared that general tuberculosis might be setting in. However, under the influence of tepid bathing and the inhalation of sulphur vapour he began to improve. I then advised his removal to Margate, his father going with him and taking charge of him. He remained at Margate about a month, and he returned home greatly benefited in every way. His temperature had become normal, and all traces of albumen disappeared from the urine.

We again recommenced our attempts to remove the tube, adopting the tactics already described. Finally, we succeeded on the 175th day after the operation. The first night he had to sleep without the tube was a very anxious time for us, for the boy seemed about to choke on several occasions. Fortunately we persevered. When his difficulties got beyond a certain point he woke up, and then his breathing became comparatively easy. These nocturnal difficulties came on again and again, and it was some weeks before he could sleep at all soundly. At the present time the patient is vigorous and strong, and has quite outgrown all his former troubles. I ought to state that the child was highly nervous, put himself into a passion, and cried very much whenever he saw me. He never got the better of this fear, although I had him under care for six months. I mention this fact because I think it helps to explain some of the difficulties of the case, especially the very variable results of the earlier trials at removal of the tube.

In this case there was a certain amount of local pharyngo-laryngitis, which rather impeded respiration at

the first trials. But as this inflammation subsided some progress was made. The child, however, was very nervous, dreaded the removal of his tube, and cried the moment any attempt was made. This led to increased congestion and swelling, which still further increased his difficulties. On the supervention of the scarlet fever, further inflammation of the throat came on, and threw us back again. Some weeks had now elapsed since the operation, and probably the effects of disuse of the laryngeal muscles were added to the already existing difficulties of the case. Meanwhile further complications showed themselves, and the general health of the patient began to fail. We now found it impossible to continue our trials, hence the child was sent to the sea-side for a month, during which time no attempt to remove the tube was made. It was corked up during the day, so that the boy used the larynx both for breathing and speaking, being allowed to breathe through the tube at night. On his return home, strong and well, we at once reattempted the permanent removal of the tube, and after some unsuccessful trials we succeeded. Meanwhile upwards of six months had elapsed since the operation; the boy had grown in size considerably in the interval, and to this fact, as much as to any other, our success was finally due.

MENTAL AGITATION, as was pointed out by Mr. THOMAS SMITH,\* plays an important part in all these cases. Not infrequently a child will breathe comfortably either with the tube corked up or (after its removal) with the opening into the trachea closed by means of the plug represented in Fig. 23 for hours together; he may even sleep quietly until some mental agitation (perhaps a dream) suddenly interferes with the rhythmical action of the respiratory apparatus, and necessitates the immediate restitution of

\* 'Medico-Chirurgical Transactions,' vol. xlviii, p. 232.



the silver cannula. In such cases the silver plug will be found very useful. It just reaches into the trachea, and so prevents the external opening from closing when the tube is removed; thus the old calibre of the trachea is available for breathing purposes. When it becomes necessary to replace the tube, the opening is ready and



FIG. 23.—A Silver or Gutta-percha Plug.

there is no difficulty. Meanwhile the habit of using the larynx is gradually restored; its performance of the healthy functions tends little by little to restore the normal nerve mechanism, which was disturbed partly by the disease and partly by the operation.

In judging how much is due to disordered nerve-function, and how much to some other (possibly mechanical) cause, we may rely chiefly on the following points: in the nervous cases the difficulty of breathing intermits, disappearing for hours together at times when the patient's attention is directed to some other subject, the voice is nearly always unaffected, and expiration is unimpeded; on the other hand, when the voice is husky, the difficulty of breathing persistent, inspiration and expiration alike difficult, we may almost feel sure that there are local conditions to account for the symptoms.

Cases similar to the foregoing are by no means uncommon; but as no two of them are exactly alike, it is impossible to lay down a hard and fast line of treatment. Perseverance is the best weapon to use; this failing, intubation, as recently carried out, seems to be the best



chance of success. In very young, anæmic, flabby children it may be well to desist from the attempts for a while. The size of the larynx and trachea is sometimes so small that success can only be looked for in their gradual growth and development. Meanwhile attention must be paid to the general health, and especial care taken that the tracheotomy tube fits well, and that no tracheal erosions are adding to the original mischief within.

#### MISCELLANEOUS CASES.

Sudden death.—There is a danger to which tracheotomy patients seem liable ; I mean the danger of sudden death. In my own experience several such cases have occurred during the last fifteen years. It would seem as if this danger is associated with injury or disease of the organs supplied by the pneumogastric nerves. Besides a case already referred to in another connection, the following cases may be given as illustrations :

CASE 1.—A well-nourished, sturdy little boy, aged eighteen months, came under observation on account of a "croupy" cough, which had commenced some four or five days earlier. He was found with symptoms of laryngeal catarrh—fever, dyspnœa, huskiness of voice, with general restlessness and want of sleep. Tracheotomy had to be shortly performed, as the foregoing symptoms soon became greatly aggravated. In opening the trachea, the isthmus of the thyroid gland was found to be unusually large, and very high up ; it had to be depressed in order to get room for the tube above it. The breathing was greatly relieved by the operation ; no membrane was got up or seen at the time. At the end of a week, the local and general condition being very satisfactory, I attempted to remove the tube, but on closing the tracheal opening found that little or no air could be passed through the larynx. There was hardly any pharyngeal complication. At the end of another fortnight I again attempted to remove the tube, with no better success. He was therefore chloroformed, and the larynx was examined as well as

could be through the tracheal wound; a soft conical bougie also was passed down the trachea and up into the larynx without meeting any impediment either way on this occasion. In subsequent trials at dilatation of the glottis (which appeared to be the seat of the obstruction) with the conical bougie I found myself frequently unable to pass it through the glottis; it appeared to hitch at some spot, but I was unable to say why; at other times the bougie appeared to pass easily. On closing the tracheal wound and obliging the child to breathe through the larynx, it became evident that there was a serious impediment, for although a little air could be made to pass, it was only accomplished with great effort, and was quite insufficient in amount to sustain life. The laryngeal condition remained unaltered for upwards of three months, an effort being made from time to time to remove the tube, but without any success. The child's general condition appeared good; he looked fat and well. One night he was found dead in bed; no sound had been heard by the night nurse, who had just previously looked at him and found him sleeping comfortably; he was found with the bedclothes undisturbed, his eyes were closed, and his features free from any sign of a struggle. The results of the autopsy were quite negative as to the cause of death.

CASE 2.—A little boy, aged one year and ten months when admitted into the East London Hospital with diphtheria, for which tracheotomy had to be performed. The disease ran its course and subsided; the tube, however, could not be removed, and the boy was discharged from the hospital several months later still wearing his tube. Some time afterwards he was admitted into Great Ormond Street, while the Shadwell Hospital was closed for repairs, and Mr. MARSH kindly took charge of him. The subsequent history of this boy I abstract from Dr. STEAVENSON'S interesting "Notes on Tracheotomy" in the eighteenth volume of 'St. Bartholomew's Hospital Reports.' "On admission under Mr. MARSH'S care the opening of the larynx into the trachea situated above the wound was totally obliterated so far as the passage of air into the mouth was concerned; but a small probe could be pressed through the granulations into the larynx. These granulations, which blocked up the opening, were brushed every few days with a solution of perchloride of iron, and a probe was passed through the opening. Later on the probe was coated with nitrate of silver and introduced into the opening. After this treatment had been pursued for several

months, the passage had so far enlarged as to readily admit the closed blades of a dilating forceps. But no attempt was ever made at speech. The child's general health continued excellent; he was allowed to run about the ward as he wished, and he became a general favourite, but he could never breathe satisfactorily without his tube. It was sometimes left out for a short time, but the child was in fear and dread until it was replaced. Often a fit of dyspnœa necessitated its re-introduction. As a rule, he wore one of Mr. MORRANT BAKER'S india-rubber tubes; but often after the tube had been left out for a few hours, the wound had so contracted that a silver one had to be used to re-dilate it.

"On the evening of March 17th, 1881, the child was found dead in his cot. No sound had been heard by the nurse in attendance in the ward; the bedclothes were not deranged; there was no foaming about the mouth; the expression was calm; the tube quite clear; in short, there was no evidence to show what had caused the child's death.

"On examination of the body twenty-one hours after death there was found marked enlargement of the circumvallate papillæ at the root of the tongue. The uvula and soft palate were thickened. The epiglottis was much swollen, the mucous membrane covering the ary-tænoid cartilages œdematous and pendulous. On opening the larynx, the whole mucous membrane was found much thickened and reddened, especially the false cords; the ventricles were patent; the true vocal cords could not be recognised. There was some constriction at the lower aperture of the larynx, but it admitted the passage of a goose-quill. The tracheotomy wound was partly through the cricoid cartilage. About an inch below this, on the anterior wall of the trachea, was a well-marked scar with some contraction. . . ."

CASE 3 was a girl about thirteen years of age, on whom I had performed tracheotomy for what appeared to be membranous laryngitis; the onset of the disease had been very sudden, and the symptoms of suffocation urgent. The girl seemed to be doing well; there was a moderate amount of tracheal secretion, which came up without difficulty. On the evening of the fourth day after the operation, while having her tea, she fell back and died suddenly. The tube at that time was quite patent; the exact cause of death could not be ascertained.

CASE 4 was a little boy four years old. He died quite suddenly on the third day while playing with his toys, and shortly after

his tea. In this case there had not been any of the asthenia which is so often a prominent feature in diphtheria; his tube was quite patent, and there was no disease in his lung.

In all these cases it is to be noted that death was quite sudden, and quite unlooked for. The breathing appeared to be normal until within a few moments of death; there was no struggling, and in those cases in which an autopsy was made nothing was found to account for death. As I have already said, I consider these deaths to be in all respects parallel with the sudden deaths (and many such are now recorded) which follow on opening or washing out, and sometimes simply on over-distension of the pleural cavity; they arise probably from a too powerful or too long-continued irritation of the peripheral branchlets of the pneumogastric nerves.



# INTUBATION OF THE LARYNX.

## IN ACUTE CASES.

SINCE the publication of the former edition of this monograph, Dr. O'DWYER, of New York, has introduced what is practically a new method of treatment for laryngeal diphtheria, viz. Intubation of the larynx.

The idea of intubation as a substitute for tracheotomy is old enough ; but the operation was never systematically carried out until Dr. O'DWYER formulated rules for its performance, invented the necessary instruments, and demonstrated their use and value among his own patients on a very large scale. For it would seem from the published statistics that laryngeal diphtheria is exceedingly prevalent in New York. Thus Dr. O'DWYER found abundant opportunity to give his method an adequate trial. He has now also many followers, not only in New York, but in other large cities of the United States ; so that the new operation, within a very short time of its introduction, can now be counted by hundreds, and seems to have entirely superseded its older rival, tracheotomy, in America.

Many papers on the subject of intubation have been published in the American medical journals within the last two or three years. I have been much struck, not only with the unanimity with which the authors advocate this operation, but also with the enormous material with which these papers deal. To select one of the most

recent, Dr. J. MOUNT BLEYER, of New York, published in the 'Archives of Pediatrics' (March, 1891), a paper giving the results of 512 cases of intubation of the larynx for croup or diphtheria, operated on between 1886 and 1890. Of these cases 37 per cent. recovered. The cases included 294 males and 228 females. The ages varied from six months to twenty-one years, 251 of the cases being under three years of age.

Such figures testify to the terrible prevalence of laryngeal diphtheria in New York. The population of London is more than double that of New York; yet if the cases of laryngeal stenosis from all causes, which have occurred in London during the same period, could be collected together, I doubt whether the number of cases requiring operation would at all nearly reach that which Dr. BLEYER has recorded as his own individual experience. Either, then, the laryngeal form of diphtheria must be immensely more common in New York than in London, or it must be felt necessary to operate on cases in New York which we, in London, should treat without operation.

In Germany, where diphtheria is much more prevalent than in this country, intubation has also been practised, yet not nearly to such an extent as in America, but the verdict on its merits is far less favourable than in America, and very much more in consonance, so far as I can make out, with the results obtained in London. Among recent papers on this subject, one of the most important is by Dr. URBAN, of the Leipzig Hospital, in which he gives a careful *résumé* of the results obtained between 15th December, 1887, and 25th March, 1888. This paper appears in the 'Deutsche Zeitschrift für Chirurgie' (vol. xxxi, pts. 1 and 2), and deals with 32 cases of diphtheria, which were treated by intubation. The age of

the children varied from one year to eight years. For one cause or another 18 out of the 32 cases had to be tracheotomised subsequently to being intubated, and all died. Of the remaining 14 cases, 11 died; the 3 cases which recovered were mild cases; the ages were four, five, and five years respectively. In commenting on his cases, Dr. URBAN admits both the utility and the need of intubation in laryngeal diphtheria. He thinks, however, that the disadvantages outweigh the advantages, and that intubation can never take the place of tracheotomy. Intubation violates one of the most important of surgical requirements, that is, rest for a diseased structure. For the tube presses on acutely inflamed parts, and changing it gives no relief, since the new tube must rest where the old did. In the matter of tracheotomy tubes, this is quite otherwise, for tubes differing both in calibre and in length can be substituted, and pressure on any given point avoided.

Both in intubation and in tracheotomy a certain manual dexterity is required, so that the one operation cannot be considered more easy or more difficult than the other. On the other hand, the after-treatment of intubation is more difficult than that of tracheotomy. As regards nourishment, he says, "Tracheotomised children swallow without difficulty either liquid or solid foods; the intubated nearly all suffer from more or less difficulty in swallowing, sometimes so severely that all nourishment is refused." The changing and cleaning of the intubation tubes can only be done by the surgeon; such duties cannot be entrusted even to the most skilful nurse. Pieces of membrane cannot be passed through the tube, and thus the child is in danger of suffocation. Dr. URBAN, after saying, that in Leipzig "intubation is entirely given up," and that during the period of trial the diph-

theria cases were of a severe type, which was probably the reason why the mortality was so high, adds, "Our decision, however, rests not on the small percentage of successes, for the figures are too small for such a purpose, but rather on the difficulties with which we were confronted in the after-treatment."

Still more recently, in the 'Deutsche medicinische Wochenschrift' (April 2nd, 1891), Dr. JULIUS SCHWALBE gives his experience at the suburban hospital of Friedrichshain, where a considerable proportion of the Berlin diphtheria cases are treated. He had only secured one success in 10 cases, whereas the average success in tracheotomy, over a number of years, had ranged from 30 to 35 per cent. This author endorses Dr. URBAN's views, as above recorded, and closes a very interesting and instructive paper with the words, "Here, also, in the hospital at Friedrichshain, intubation has been entirely relinquished."

My personal experience of intubation during the acute stage of diphtheria is limited to four or five cases, so that I hesitate to draw any conclusions from it, still less to attribute failure in these first cases to the method, instead of to my own want of skill in carrying it out. American surgeons complete the operation in from two to five seconds after the gag is once in position. I can make no pretence to such a record. In all my cases dyspnoea was urgent before the operation, and the introduction of the gag, and the preliminary arrangement of the patient, so much increased the dyspnoea that I feared death would occur. In one case I had, as rapidly as possible, to perform tracheotomy.

Intubation was tried during 1890 at the East London Hospital for Children at Shadwell, in five cases of acute diphtheria. Dr. HASTINGS, the resident medical officer,





There were 8 males and 7 females ; the ages ranged from one year to eleven years.

“Two cases recovered ; one, female, suffering from diphtheria, aged two years, who wore the tube four days and made an excellent recovery ; the other, male, suffering from scarlatinal laryngitis, aged three years, who coughed the tube up after ten hours, and in whom it did not require replacing.

“Some difficulty was experienced in inserting the tube in some of the cases, but it was not of a serious character ; in no case was membrane detached and pushed down before the tube (one case of this kind has, however, occurred this year). In one case the tube slipped down into the trachea after having been worn some days.

“Ulceration, more or less extensive, was found *post-mortem* in 6 cases, in 2 of which it had proceeded to very extensive destruction of the laryngeal cartilages and rings of the trachea ; excoriation was found in one case after the tube had been worn eight hours.”

Dr. MACCOMBIE thus sums up his views on intubation :

“1. Its suitability as regards the nature or severity of disease.—In all cases of laryngeal obstruction intubation should be done early ; if patient is seen late in disease and when almost moribund there is considerable risk of the patient dying from shock under the operation. As regards age of patient, suitable at all ages, but over six years of age is probably less suitable than tracheotomy, and under eighteen months children may have alarming syncopic symptoms on the fixing of the gag (2 such cases here, tracheotomy done on both and patients lived some time).

“2. Duration of intubation.—Danger of intubation increases with the length of time the tube is retained. Danger consists of ulceration of larynx and trachea, and is due to the pressure and irritation occasioned by the tube. Tube should not be retained for more than twelve hours before being removed; to be re-inserted if necessary; if patient cannot breathe without tube thirty-six to forty-eight hours after the first insertion, tracheotomy should be performed.

“3. Advantages.—(a) Celerity, and in most cases ease of operation; (b) relief of dyspnoea either complete or else euthanasia; (c) need for constant attention on the part of nurse less necessary than in tracheotomy; (d) No wound, as in tracheotomy.

“4. Disadvantages.—(a) Risk of separation of membrane and its being pushed down before the tube during introduction, patient may die before tracheotomy can be accomplished; (b) risk of child coughing up tube and dying from asphyxia before the tube can be replaced; (c) danger of ulceration of mucous membrane, and cartilages of larynx and trachea. Tube may slip down into trachea when much ulceration takes place; (d) difficulty of membrane, when detached, escaping through the tube.”

#### IN CHRONIC CASES.

Although I have not been able to say much in favour of intubation in acute cases, still in the 3 following chronic cases this plan of treatment has proved eminently successful.

The cases were all children. Two had had diphtheria,

and had been tracheotomised eighteen and seven months respectively previous to the intubation. In neither of the cases had it been possible to remove the cannula for more than a few minutes; in one of the cases every sort of treatment had previously failed. In the third case the boy had been tracheotomised for scald of the glottis eleven and a half years previously. After wearing his tube for five or six years and after great difficulties, it was removed. But in the course of a few days after leaving the hospital, and about a month after the tube was finally removed, his dyspnœa became urgent, and tracheotomy had to be done for the second time. All our further trials during the next five years proved unavailing. The chief facts of these 3 cases are as follows:—

Case 1.—Boy, aged  $4\frac{1}{2}$  years, suffered from diphtheria (supervening on scarlet fever) of a severe and sloughy type. He was tracheotomised on the ninth day, and recovered, but was much debilitated by the disease. There was considerable loss of substance with subsequent cicatrisation in the pharynx and upper part of the larynx, which led to some tension of the palate, of the adjoining arches, and of the ary-epiglottic folds. Efforts to remove the tube were commenced early and persisted in but without success. The boy was unable to breathe for more than five to eight minutes without his tracheotomy tube. Bougies were passed up without difficulty, but the larynx seemed to close after their withdrawal much as a urethral stricture does after catheterisation. All our efforts having failed, eighteen months after the operation, it was decided to try intubation. Mr. SYMONDS was invited to give us the benefit of his larger experience and to undertake the operation, which he kindly did. Owing apparently to the altered relation of the parts, considerable difficulties were experienced in introducing an intubation tube; but it was finally accomplished. The tube was worn for seventy-two hours, and was then coughed up. He had appeared to breathe comfortably while the tube was *in situ*, but he breathed still more easily without it: there was no need to re-introduce it. The boy now rapidly improved. I saw him on March 5th, 1891. The breathing is rather louder than normal, but there is



no difficulty of any kind. The voice is hoarse; he snores very loudly when asleep, but sleeps soundly. That the boy recovered from his acute illness was entirely due to the assiduous care of Dr. ALEXANDER MORISON of Highbury, with whom I saw him in consultation.

Case 2.—Boy, aged 3 years: was tracheotomised in the Homerton Fever Hospital by Mr. S. Dickinson for diphtheria. All went well, except that the tracheotomy tube could not be removed. Every effort was made and failed. He was admitted into the Children's Hospital, Shadwell, on October 15th, 1890, five months after the operation. Various measures were there tried, but without any better success. The utmost we achieved was to get on without the tube for twelve hours, after which his dyspnœa became so urgent that his tracheotomy tube had to be replaced. Intubation was then practised, under chloroform. The boy pulled out the O'Dwyer tube after it had been worn for about forty-eight hours and it had to be replaced; it was immediately coughed up again; then a larger tube was inserted and this was worn, without any discomfort, for a week; it was then removed. The tracheotomy wound was, by this time, quite closed. He could breathe quite comfortably. The improvement was permanent. The voice was rather hoarse at first, but this hoarseness gradually passed off.

Case 3.—Boy, aged  $2\frac{1}{2}$  years, was tracheotomised in April 1879 for a scald of the glottis (from sucking the spout of a kettle). He went on well, and in due time trials of his breathing powers without the tube were made. But notwithstanding every effort these trials were all quite unsuccessful. He was discharged from the hospital and readmitted on several occasions. In August, 1884, he was again taken in, and the tube was removed. For six weeks he breathed fairly well, and was discharged. He had to be re-admitted within a few days, and as his breathing became more and more laboured the trachea had to be re-opened and the tube put back. He wore this tube until November, 1889. Further trials were then made to do without the tube, and were again unsuccessful. In January, 1890, an O'Dwyer's tube was put in, which he wore for sixteen days. It was then removed, but had to be quickly replaced as the boy was quite unable to breathe without it. The tube was again changed after thirteen days, when there seemed to be little or no improvement in the breathing. So the tube was again replaced, and was worn con-

tinuously from January 29th until November 9th, 1890. The boy experienced no pain or discomfort. After the first few weeks he lived at home and came to the hospital every two or three days to be examined. When removed the surface of the tube was quite black, all the electro-gilding being removed. The tube was tightly gripped by the larynx, and some force was necessary to displace it. Since its removal the boy has breathed quite comfortably, and his voice is largely restored.

In this case intubation proved a most valuable operation. I had lost all hope of remedying the condition, and feared that the tracheotomy tube would be required for the rest of the boy's life.

In chronic cases arising from almost any cause, where the surface of the larynx is more or less healthy, I should anticipate a favourable result from intubation. In cases, also, of false croup, in cases of œdema of the glottis, that is to say for evanescent conditions, intubation will probably give satisfactory results.

But in acute cases, I have thus far got more help from tracheotomy than from intubation. For the present I shall continue to advocate and practise tracheotomy as the more rational and safer method of treating laryngeal diphtheria during the acute stage.

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BY THE SAME AUTHOR.

*Pp. 105, with 42 illustrations.*

## THE NATURE AND TREATMENT OF CONGENITAL CLUB-FOOT.

WITH ESPECIAL REFERENCE TO THE PART PLAYED BY THE TARSAL LIGAMENTS IN MAINTAINING THE DEFORMITY, AND THE IMPORTANCE OF DIVIDING THEM, IN SUITABLE CASES.

The argument.—The feet should occupy varying positions during the course of intra-uterine life, in order that the muscles, the ligaments, and the joint surfaces shall be so developed as to allow of that variety of movement which the normal foot enjoys. Should anything prevent the feet from assuming these positions at the proper time, or maintain them in any given position beyond the limit of time during which they should normally occupy such position, a talipes results. The severity of the deformity will be in direct ratio to the violence at work: the variety of the deformity will depend on the period when this violence first begins to work.

The anatomy of club foot is described in detail, from dissections by the author conjointly with Mr. SHATTOCK: the conformation of the astragalus in man and in the higher apes is also discussed.

The insufficiency of the theory that the deformity depends upon a nerve lesion, or upon some abnormal conformation of the astragalus is insisted upon; while the various mechanical means which may bring about talipes are illustrated, and the general applicability of a mechanical cause to explain all forms of talipes is maintained.

It is further shown:—(1) That certain of the tarsal ligaments are relatively short, owing to the developmental malposition of the bones between which they lie; (2) that this anatomical condition is constant, and is the chief impediment to the reduction of the deformity.

It is then argued:—(1) That simple tenotomy leaves the major part of the anatomical condition untouched; (2) that relapses, which so frequently occur, are due to the unyielding nature of the ligaments, and that the obvious remedy is to divide them.

### SOME OTHER CONTRIBUTIONS.

Case of Scald of the Glottis, with Deposit of a Diphtheritic Membrane in the Pharynx, Larynx, and Bronchi.

Clin. Soc. Trans., vol. viii, 1875.

On a Case of Primary Cylindrical Epithelioma of the Lung. (With  
Dr. Finlay.)

*Borrowed from the Library, Roy. Coll. of Physicians.*

*Notes & treatment of Diptheria  
(Packer)*

*Wm Ross*

*August 1891*

Path. Soc. Trans., 1888.

Fatal case of Pyopericardium, treated by Free Incision and  
Irrigation.

Clin. Soc. Trans., vol. xxii, 1889.

PRINTED BY ADLARD AND SON, BARTHOLOMEW CLOSE.



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